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TRAUMATIC CYANOSIS—ITS PATHOLOGICAL PHYSIOLOGY

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TRAUMATIC cyanosis, or asphyxia, is a phenomenon produced by the suspension of respiration for a time, due to enforced compression of the thorax, or thorax and abdomen. This results in a purplish discoloration or cyanosis of the head and neck, and in subconjunctival hemorrhages. There is, of course, a generalized reaction which may or may not terminate in death. The number of these cases studied in life is very small, and most of those living for a time after the injury was sustained, recovered. However, contrary to Green's statement that most cases recover, this statement should be limited to the cases studied in life, for there are many reports of cases dying with this syndrome after crushing injuries sustained in panics and mobs. In fact, the first to report the syndrome was Ollivier, who reported twenty-three cases crushed to death in the Champs de Mars crowd (June 14, 1837). The peculiar discoloration of the face and neck was found in all of these cases. Autopsies on nine of these cases showed no cerebral hemorrhages. The blood was black, fluid, and filled all the veins running into the heart. Punctate hemorrhage occurred into the loose tissues of the scalp on the surface of the pleura, pericardium, heart and abdominal viscera. There was extravasation of blood under the conjunctivæ.

From the crowd of the Pont de la Concord there are nine cases of this syndrome reported by Tardieu (1870).

The following is a brief report of a recent case, No. 2059 (1926), at the Harper Hospital of Detroit:

History.—A single, white, Polish laborer, thirty years of age, was received at the Harper Hospital, February 15, 1926, as a traumatic emergency. A short time before entry he was compressed against a stone wall by a steam shovel. He was relieved from his predicament very quickly and brought at once to the hospital.

Except for a crushing injury to his left lower leg (requiring amputation), two years ago, the patient had always been well and without complaint.

The man was a very well-developed and nourished young white male, in great pain and in shock. His face, neck and the upper part of his shoulders were literally as blue as indigo, but the remainder of the body, although not of good color, was not so remarkable. There were extensive subconjunctival hemorrhages in both eyes. The cyanosis paled slightly on pressure.

Neck.—Very blue to the clavicular lines.

Chest.—Great pain in upper right chest in front, with tenderness. There was a bony irregularity of second to fifth ribs on the left—an area being raised above the level of the rest of the thoracic cage. There was a slight amount of subcutaneous emphysema lateral to this area.

Lungs.—There were fine, crepitant râles heard all over the right chest in back. No other abnormalities of voice or breath sounds or percussion except the area over the bony irregularity which was not percussed because of great tenderness.

Heart.—No apparent displacement. No increase in size. Sounds clear and of good quality. No murmurs or thrills. Rate 140 per minute. Pulse of fair volume and tension.

Abdomen.—Generally resistent, but no tenderness.

Pelvis.—There was tenderness and pain on pressure over the bony pelvis.

Extremities.—Left leg amputated (old) below knee.

There was a large bony protuberance posteriorly in the region of the left scapula. This appeared to be the acromial process of the clavicle which was displaced backward.

Treatment and Progress.—Patient was given oxygen: morphine gr. ¼, the morphine repeated in an hour; heaters and blankets were applied; atropine gr. 1/150 and caffeine sod. Benz. gr. viiss were given. Fluids were given by mouth.

The patient's pulse was up to 140 and thereabouts for the first four days, and then gradually declined to normal. His temperature reached 102.2° on the third day, and gradually declined to normal. The respirations were between 28 and 40 for the first nine days and then gradually reached 20 and remained there.

X-ray showed a double fracture line in the inferior ramus of pelvis with a displacement of the fragments at the inferior fracture. There was a fracture of the superior ramus well posteriorly. A film of the chest revealed some clouding of the right lung field. There was some evidence of fracture of the second rib at the lateral chest wall. The left lung was not collapsed. A film of the left shoulder showed elevation of the distal end of the clavicle but no fracture.

Except for morphine, and later codein, aspirin and sodium bromide, the treatment was limited to complete rest, strapping of chest, until March 27, when an open operation for reduction of the clavicle was undertaken under nitrous oxide-ether anæsthesia.

The patient's general condition continued to improve slowly, and he was discharged on April 17, 1926, the sixty-third day. His remarkable cyanosis of the face and neck and upper shoulders still being evident but not so marked, and all but a trace of his subconjunctival hemorrhage having disappeared. At no time did the cyanosis change to the green and yellow color associated with extravasated blood forming the bile pigments.

Word from Doctor Naylor who saw the patient two months after discharge is that the cyanosis had completely cleared up, and the conjunctivæ were normal except for a muddy appearance.

There are certain considerations in regard to this syndrome which are well illustrated by this case.

The type of injury usually is as here, a crushing injury of the chest or of the chest and abdomen, causing a cessation of respiration. The chief causes of this injury have been crowds or panics, elevator accidents, injuries by trains or other vehicles. The clinical characteristics are: The color of the skin of face, head and neck, which varies from "dark red to purple." It is described both as discrete and confluent. It is reported as extending down as far as the third rib on the chest and in back to the level of the lower border of the trapezius muscle.

Subconjunctival hemorrhages are common.

Convulsions have been known to occur.

FIG. 1.—Traumatic cyanosis.

The interesting point in relation to this syndrome is its pathological physiology: First, what happens? The compression of the thorax causes cessation of respiration, increased intrathoracic pressure, and thus compression of the superior vena cava; the latter causes the venous blood therein to attempt to get backward.

Second, why the peculiar distribution of the cyanosis, as described? Perthes' explanation is that there is a lack of competent valves in the veins in this area: "There are no valves in the innominate and internal jugular veins except a pair where jugulars enter the innominate. There are two pairs in the external jugular—one at its junction with the subclavian, and the other just above the clavicle." All of these are incompetent.

Third, why the discoloration or cyanosis? There is a great difference of opinion on this topic. Hueter says that, (1) it is due to the extreme distention and rupture of the vessels of the skin from the sudden upward pressure; or, (2) that, due to the trauma, there is sympathetic nerve paralysis leading to vasomotor paralysis, which leads to the distention of the vessels with blood. Perthes believed that the capillaries are actually ruptured. Burrell and Crandon accept the paralysis theory. Beach and Cobb feel that there is not an extravasation of blood outside the vessels, but that the upward pressure has caused the dilation of the vessels in the region of the incompetent or absent valves. These investigators removed sections of skin for microscopic study and found normal skin except for dilated vessels. There was no sign of extravasated blood or of ruptured vessels. They also pointed out that the discoloration blanches a little on pressure, and does not go through the various stages of coloration as seen in extravasated blood.

Winslow found, on microscopic section from his case, that the condition was as described by Beach and Cobb. Bolt's findings agreed with the above three observers: Robertson and Braun, however, found blood in tissues of skin outside the blood-vessels.

The case here reported showed no change of the cyanosis to the various stages of discoloration as seen in extravasated blood. A specimen was unable to be obtained.

These cases frequently have severe ocular or visual injuries. There are reported cases of optic atrophy, retinal hemorrhage and degeneration following traumatic asphyxia.

CONCLUSION

1. A case of traumatic asphyxia is reported with recovery.

2. The prognosis, from the literature, is good if the trauma is not fatal shortly after its occurrence.

3. The cyanosis of the head, face and neck, with subconjunctival hemorrhages is characteristic of the condition.

4. The distribution of the cyanosis is probably due to incompetent or absent valves of the region, allowing back pressure produced by compression of the superior vena cava to cause a distention of, or a paralysis and a stasis in, the small vessels.

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APPLICATION OF THE PRINCIPLE OF THE QUARANTINE IN ABDOMINAL SURGERY*

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An address on an occasion of this kind should deal with general principles. While the principle of the quarantine has been much used in abdominal surgery, it has not been sufficiently defined and isolated as a principle. Rather has it been classed under the general heading of "Drainage".

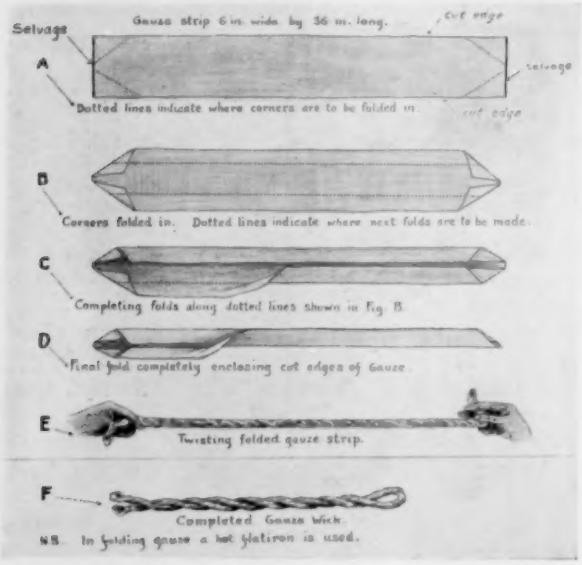
Selvage
Gauze strip 6 in. wide by 36 in. long.
cut edge
A
selvage
Dotted lines indicate where corners are to be folded in.
cut edge
B
Corners folded in. Dotted lines indicate where next folds are to be made.
C
Completing folds along dotted lines shown in Fig. B.
D
Final fold completely enclosing cut edges of Gauze.
E
Twisting folded gauze strip.
F
Completed Gauze Wick.
N.B. In folding gauze a hot flatiron is used.

Fig. 1.—The preparation of a double gauze wick.

Long ago surgeons discarded unprotected gauze as a drainage agent in the abdomen. This is correct when applied to pure drainage of an enclosed cavity, such as the entire abdominal cavity in a general peritonitis, or an enclosed abscess cavity wherever found. Therefore, in general peritonitis a tube or other nonporous substance is preferred. Likewise, for an enclosed abscess cavity. Yet, under certain circumstances, when properly used in sufficient quantity, gauze is the most efficient of all drains, but it must never be allowed to come in contact with the free peritoneal surfaces in the general peritoneal cavity. In as much as drainage is a necessary part of a quarantine, it is necessary to discuss the principles of drainage when applied to the abdominal cavity.

Yates,† in his article on "Local Effects of Peritoneal Drainage," confirms the findings of previous investigators and makes the results more definite by his experiments. The experiments were with all forms of drainage, and by using many dogs he was able to definitely determine the time at which drainage ceased from the peritoneal cavity cases. By placing different forms of drains in the flanks of dogs and then in a certain number of hours filling the abdomen through an opening at the ensiform cartilage with carmine solution, he was able to determine definitely that all forms of drains were

* President's Address before the Western Surgical Association, October 14, 1926.

† Surgery, Gynæcology and Obstetrics, December, 1905.

closed, so that absolutely no drainage from the peritoneal cavity would take place after six hours.

By quotations from many investigators and experiments of his own, he concludes that drainage produces a flow of serum (lasting from a few hours to two days), which in quantity is out of all proportion to the fluid in the cavity to be drained, but in exact proportion to the amount of drainage material inserted, showing that the serum was poured out as a result of the irritation produced by the drains. From the work of other investigators and confirmed by his own experiments, he finds that gauze will not drain pus or blood.

Acting on these facts, he condemns drainage of the peritoneum, as a rule, on the grounds, (1) that it is impossible; (2) it is depleting; and (3) pus and blood are not drained.

I believe that the scientific findings of Yates are correct and fundamental as far as they go. Capillary drainage is usually carried out by means of gauze which may or may not be encased in some smooth tube or tissue.

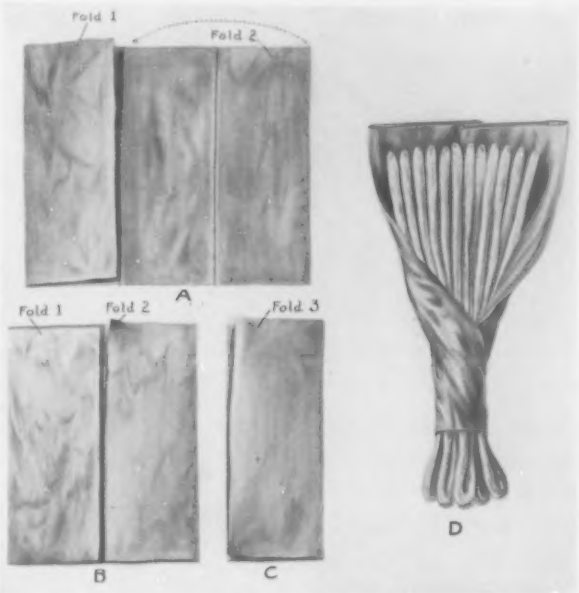

FIG. 2.—*A*, *B* and *C* shows steps in folding rubber tissue into a four-ply fold. It will be noted that only turned corners are exposed, raw edges enfolded. *D*, architecture of quarantine when in place.

My findings, both experimentally and clinically, confirm the conclusion of Yates and others that gauze will not efficiently drain pus or blood from a basin, nor from a closed abscess cavity. It will, however, drain either pus or blood from the free peritoneal cavity. Even coagulated blood or thick pus is liquified by the excessive flow of serum (noted by Yates as being useless and depleting) and is delivered to the surface in the form of a thin red non-coagulable fluid in the case of blood and a yellow fluid in the case of pus, which will frequently saturate the dressings and all the bedding in a short time, if the drainage material is sufficient in quantity and properly placed. Thus this seemingly useless flow of fluid serves the purpose of a solvent, and at the same time acts as an irrigator from within, out, in a manner impossible by artificial irrigation.

By experiment, it is found that ten gauze wicks will drain exactly ten times as fast as one over the edge of a basin or out of a cavity. Therefore, drainage will be in exact proportion to the amount of gauze passing through the external wound. In draining water over the edge of a basin the flow ceases

when the water reaches the level of the outside end of the gauze, but starts again if a piece of gauze is pinned to the end of the drain and flows with a rapidity proportionate to the length of the external gauze below the level of the fluid in the basin, thus acting on the principle of a siphon.

FIG. 3.—Each wick end is carefully placed in the desired location with a long handled forceps making a row across the pelvis. After the wicks are in place, two rubber sheets are made to cover all these wicks.

A gauze strip packed in a cavity like the " folds of a fan " and communicating with the surface by only a small end of the gauze strip, as described and condemned by Clark,‡ creates a flow of serum in proportion to the amount of gauze in the abdominal cavity, but serum is delivered to the surface only in proportion to the size of the strip passing out through the wound. Hence the large secretion of serum, and later of pus, surrounding the drain (mentioned by Clark), which was not delivered because of the insufficient drainage at the outlet and which later produced chronic fistula because the internal cavity was larger than its outlet.

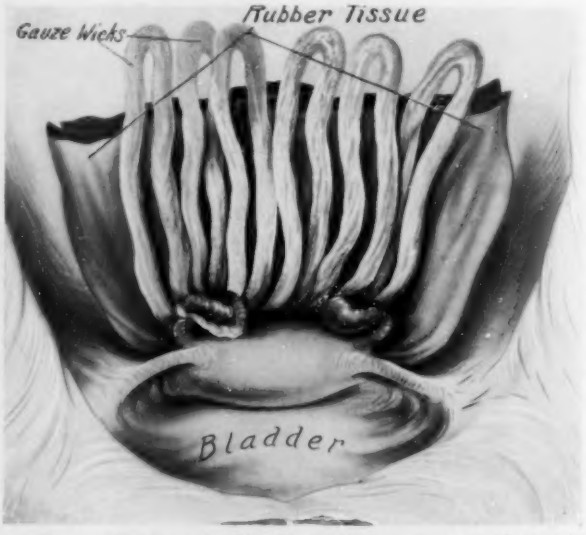

FIG. 4.—Wicks and rubber tissue in place and turned back to show their relation to the open tubes and uterus, the loop ends to be cut off after the wound is closed around the quarantine, making twelve single wicks.

Another feature which Clark did not emphasize in this connection is that in the use of the gauze pack in the abdominal cavity with an insufficient outlet for the flow of serum very extensive adhesions develop in the neighborhood. It may be said that the flow of serum is a stream of water bringing soldiers and materials for defense to the seat of warfare to be used against a foreign body or enemy. This flow carries not only warriors, but materials for building a defensive wall

‡ Jour. of Obstet., and Dis. of Women and Children, April and May, 1897.

against the intruder. The materials are brought in proportion to the size and strength of the enemy or intruder. Nature is lavish in her defenses and therefore brings more materials than are necessary. As the water which has transported these materials to the field is absorbed, the fibrous elements gradually thicken, and if the quantity is too great, remains in the form of adhesions. Therefore, if drainage is to be used in the peritoneal cavity, it must be of sufficient quantity and of proper quality to deliver the substance to be drained, as well as the excess serum, to the surface within a few hours. Therefore, if gauze is to be used as drainage, it must be in considerable quantity and the diameter of the drain must be as great where it emerges through the abdominal wall as at any point within the abdominal cavity. Furthermore, it must be surrounded by a smooth, impervious substance, such as rubber tissue.

FIG. 5.—Wicks in place showing how rubber tissue is interposed between gauze and free peritoneal cavity. Omentum where possible is interposed between intestines and rubber tissue.

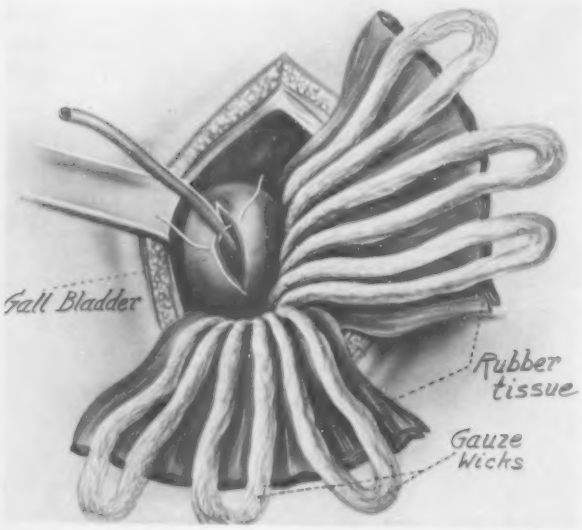

FIG. 6.—Method of placing quarantine around a septic gall-bladder in an emergency where it is thought impractical to remove gall-bladder at the time. The rubber tube is non-essential.

It is the purpose of this paper to isolate and apply the quarantine as a fundamental principle and I shall use it in the sense of a structure which has for its purpose the segregation or separation of an infected or diseased area from the remaining free peritoneal cavity. Such a structure to be workable must possess the following qualities:

1. The surface on the side of the general peritoneal cavity must be smooth and inoffensive to the abdominal organ coming in contact with it.

2. It must remain accurately in place.

3. It must provide ample drainage of the infected or injured segment.

4. It must be so constructed that it may be removed with the least possible trauma.

The first quality is met by the use of an outside rubber tissue covering. The second by carefully arranging gauze wicks around the infected area. The gauze being porous and rough rapidly fastens itself to the tissues where it is placed and thus anchors the quarantine. The third (ample drainage of the segregated area) is provided by gauze leading to the surface. Fourth, this gauze must be arranged in small wicks so that one may be pulled at a time without disturbing the defensive wall that Nature has placed around the quarantine.

FIG. 7.—Sub-cæcal abscess surrounding a walled-off gangrenous appendix.

A very important detail is the construction of a wick which is strong and which at the same time has no ravelling edges. Such a wick is made from strips of gauze five or six inches in width, cut across a 36-inch bolt of gauze. We have used Seabury and Johnson's Monitor gauze because of its strength. The steps in constructing this strip into a wick are shown in Fig. 1. It will be seen that the ends of the wicks are formed by the two selvage edges of the bolt of gauze. All the cut edges are securely turned in and ironed with a flat iron and the wicks twisted. The two ends are then brought together and again twisted. Six of these double wicks are placed in a package for sterilization. When unfolded for use, the two ends of the wick are untwisted from each other, but the pressing and twisting used in the preparation prevents the wick from unfolding and exposing the raw edges. When put into place, each wick is laid separately, bringing the middle or loop to the surface. After the loop is cut, the two ends left in the wound make two wicks to be removed. Twelve wicks of this kind are sufficient for holding a quarantine in place and draining the area. When these twelve wicks are massed together, brought to the surface and surrounded by four thicknesses of rubber tissue, a made-in cigarette drain approximately an inch in diameter is the result. The lower end is spread out in the shape of a fan, Fig. 2D, to surround the area to be quarantined.

The gutta percha covering is constructed as follows: Bauer and Black extra heavy tissue is used. It comes in bolts 5 yards long, 36 inches wide.

This bolt is cut transversely into strips one foot wide which would make fifteen strips in each bolt. Each strip is cut in two in the middle, leaving two pieces of tissue 12 x 18 inches. This strip is folded in its long diameter to four thicknesses, making a four-ply sheet of rubber tissue 12 inches long, 4½ inches wide, in which all cut edges are turned in, leaving none but folded edges exposed. By this method of folding, the greatest strength of the gutta percha fibre is longitudinal and therefore the sheet will not tear transversely. Aseptically the gutta percha is prepared and preserved as follows:

Gutta-percha, after it is cut in the desired length, is put in 1–1000 bichloride and allowed to stand over night. It is then dried with sterile linen and folded, making it ready for use. It is kept in a glass jar which has been autoclaved or boiled. This is done with sterile gown and gloves.

It is easier to apply a rubber tissue covering in two pieces of four and a half inches in width than one nine inches in width. Therefore, two pieces are always used, three if necessary to effectively cover in the gauze.

FIG. 8.—Quarantine in and around a sub-cæcal abscess cavity. Ileum is held straight by quarantine.

Speaking in terms of general principles, we have the following indications for the use of the quarantine in abdominal surgery:

1. Infected organs which tend to produce a peritonitis by contact or discharge but which organs are not to be removed.

2. Intra-abdominal abscess so located that the wall is exposed to the intra-abdominal viscera and where the discharge must be conducted across the free peritoneal cavity after drainage is established.

3. An open viscus which because of the presence of infection or for other reason it is impractical or undesirable to close at the time.

4. Large denuded bleeding or infected areas where it is impossible to cover with peritoneum.

5. Extensive recurrent adhesions which disturb the function of abdominal organs.

Under the first heading, the most frequent application is for an infected uterus and tubes such as follow miscarriages, criminal abortion, gonorrhœal infection, etc. All these infections tend to produce peritonitis, form abscesses,

or even general septicæmia and finally to leave a morbidity in the form of extensive adhesions which prevent the patient from enjoying health, although fatality is averted. There is nothing more like magic than the result after quarantining a septic uterus and tubes due to a pyogenic infection. Even tubes which are sealed and which contain acute abscesses may be split open and allowed to remain. The acute peritonitis and other septic symptoms will often disappear immediately after the quarantine has been placed. If the infection is due to the gonococcus, the same startling transformation takes place. If the tubes have not been sealed and a quarantine is thus placed, the fever immediately subsides and in the few cases in which I have used it before the tubes have become sealed, no recurrence of symptoms has taken place. No organs were sacrificed and no sequelæ or recurrence occurred such as follows so-called conservative treatment. In a much larger number of gonorrhœal cases in which the tubes were sealed and pus tubes had formed, the tubes were removed. If the infection is pyogenic, it is unnecessary to remove the tubes even though they are closed, for they may be split and laid open and brought within the scope of the quarantine. If the infection is known to be gonorrhœal and the tube has become sealed, it must be removed, for it is rare that a tube sealed by gonorrhœal infection opens and rarer still that it functions. By this means, the ovaries may almost invariably be saved even if the abscess involves the ovary. The abscess cavity may be laid open and drained and recovery will take place. In short, (a) the early quarantine of a gonorrhœal tube during the first attack of local peritonitis saves both the tubes and the ovaries and relieves the patient of much suffering and danger. (b) Even if the tubes have been sealed, the ovaries may be saved and the patient relieved of further morbidity and suffering.

FIG. 9.—Method of application of quarantine surrounding an open duct which is septic or may possibly contain additional stones.

Figures 3, 4 and 5 show the technic for the application of the quarantine pack for pelvic infections. The field is carefully exposed. The intestines are packed well up into the abdomen. The tip of each gauze wick in a long-handled forceps is placed at the exact point where it is desired to make a coffer-dam across the pelvic inlet. Usually the twelve wicks in one package are sufficient. These are laid perfectly straight, then the two sheets of four-

ply rubber tissue are neatly fitted around the gauze until it is entirely covered on its posterior surface and carefully fitted around all the gauze above the fundus of the uterus, making of the quarantine a large cigarette drain as it comes out of the abdomen which has been expanded into a fan-shape inside the abdomen. (See Fig. 2D.)

Another striking instance coming under the first heading is a septic or gangrenous gall-bladder which is particularly apt to occur in feeble old people. In such a case an incision is made through the right rectus muscle under local anæsthesia. The intestines are packed downward lightly with a moist gauze pack. A gloved hand gently slips in under the gall-bladder. A dozen wicks are arranged around it, and two sheets of rubber tissue on the outside of these. (Fig. 6.) A stab wound is made in the gall-bladder, its contents removed and the incision closed. This is done without shock. Such a patient will often be tided over to good health when, if necessary, the gall-bladder may be removed very simply. For, after the use of the quarantine pack there are practically no firm adhesions such as occur following the introduction of a small drain for the reasons, (a) the drainage is sufficient to remove the excess serum with its fibrin-forming content; (b) rubber remains for two weeks interposed between two peritoneal surfaces, after which firm union does not take place.

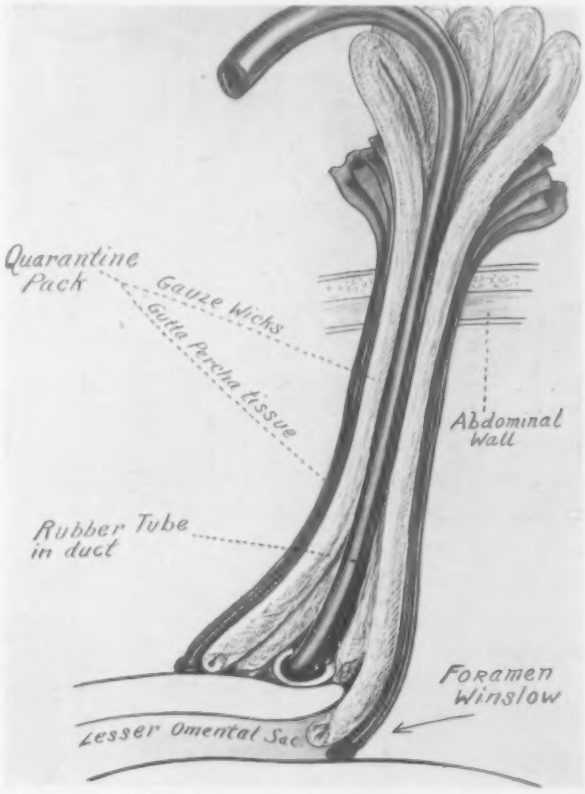

FIG. 10.—Sectional view of combined quarantine and drainage tube in place.

The most outstanding instance of the second indication is that of the retro- or sub-cæcal abscess in cases of appendicitis. Figure 7 shows such a case. The coils of intestines have arranged themselves around the infected appendix to form an abscess wall which is located on the back wall of the abdomen underneath the end of the cæcum. A simple drain placed in such an abscess may save life, but the post-operative morbidity is great. Many cases of intestinal obstruction follow such drainage, for the loops of bowel imme-

diately arrange themselves around the drainage and attach themselves again to the abscess wall and very firm adhesions take place and post-operative obstruction often occurs—many times before the patient leaves the hospital.

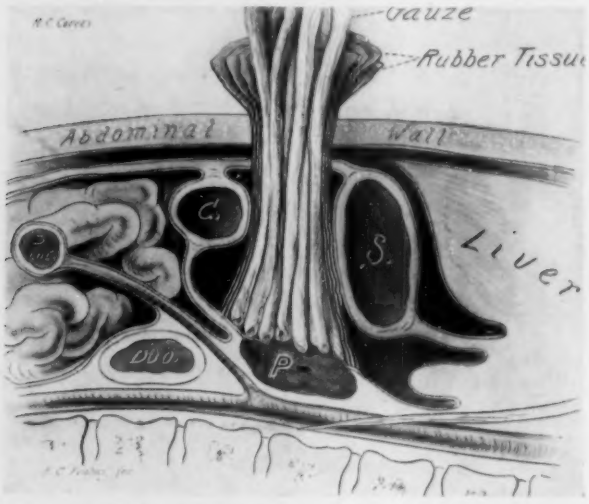

FIG. 11.—Application of quarantine where it is desired to drain an injured or infected pancreas.

Some have sought to avert this by using three or four cigarette drains, say, for instance, one in the pelvis, one in the abscess cavity and one in the flank. The post-operative morbidity is no less in this form of drainage than in single drain just mentioned, for the reason that the loops of bowel work in between the cigarette drains and attach themselves to the abscess wall. Many such cases die unnecessarily in the hospital as a direct result of the operation. Others die in the hospital as a result of intestinal obstruction. Still others, months or years later, require operation for intestinal obstruction due to the adhesions formed as a result of this defective form of drainage. For such a case a quarantine is ideal. The abscess cavity is lined with the ends of a dozen wicks. The gauze is then surrounded by the two sheets of four-ply guttapercha tissue. The ends of this gutta percha passes along the parietal peritoneum somewhat beyond the abscess cavity. The omentum is then drawn down to the neighborhood and against the pack. In such a case, not only is the drainage perfect, but post-operative adhesions and post-operative obstruction is practically unknown. The same plan is applicable in perforating diverticulitis of the sigmoid, abscess of the liver, etc. (Fig. 8.)

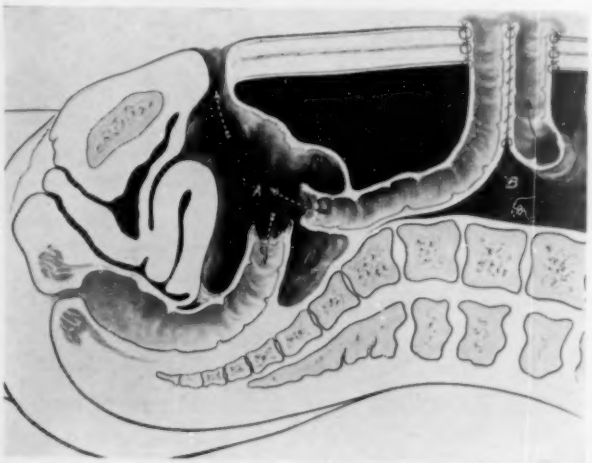

FIG. 12.—Two ends of severed intestine opening into a large abscess cavity; direction of fecal current before operation indicated by dotted arrow A. B, transverse colostomy instituted as first step toward final cure.

The most frequent case of Type III is found in common bile duct surgery in which the bile tracts are infected and in which pus or stones or both are in the common bile duct. Sometimes it is suspected there are stones well up in the hepatic ducts and it is desirable to leave the ducts wide open to permit of their escape. At other times, the tissues around the duct are brittle, the cavity is deep and it is difficult to fasten tubes accurately in the common duct. In such a case, the quarantine pack is indicated. Figure 9 shows the application of a quarantine drain combined with a tube in such a case. The ends of the first wick are placed in the foramen of Winslow. The ends of remaining wicks are then carefully arranged upward along but just above the duodenum. It is important not to infringe upon the duodenum at any point. Finally the last wicks are placed beneath the liver above the duct. The tube and the gauze are then lifted upward and the two sheets of rubber tissue carefully arranged around the wicks so that no abdominal viscus can come in contact. A tube tacked lightly in such a duct admits of the possibility of drainage around it and yet if there is no obstruction, it will deliver the bile through the tube, thus saving dressings. The danger to the patient is no greater, however, if the duct is left wide open and no tube is used at all, no matter whether infection is present or not. Figure 10 shows the application of a quarantine of this kind.

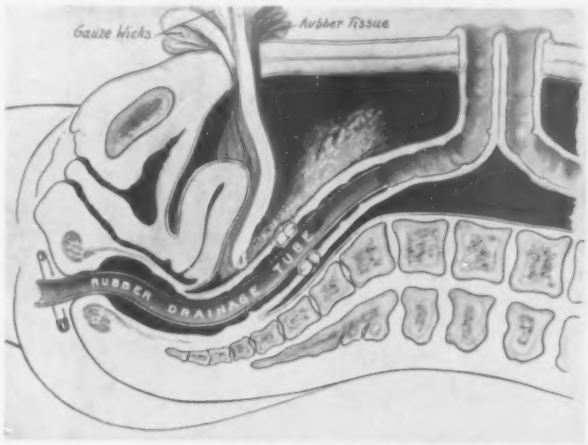

FIG. 13.—Intestinal anastomosis in the presence of an infected field protected by omentum, quarantine pack, temporary colostomy and a rubber drainage tube used in case illustrated in Fig. 12.

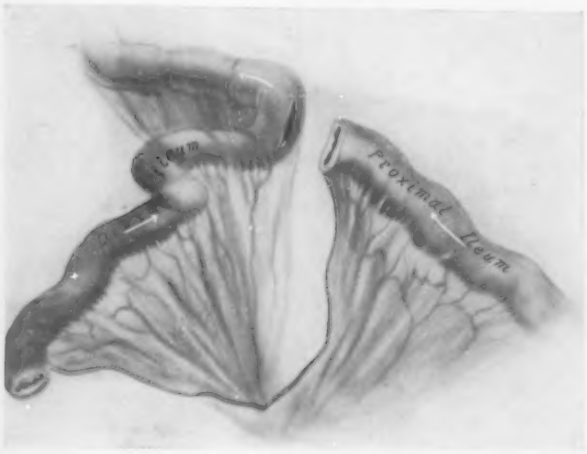

FIG. 14.—Preparing mesentery of the ileum to be used as a patch over hole in pelvic colon.

Another type of case coming under Classification III is found in traumatic rupture of the pancreas, removal of a stone from the body of the pancreas,

the opening of an abscess of the pancreas, etc. It has been proven by Opie, the writer of this paper and others, that fat necrosis is always due to escape of pancreatic fluid into the retro-peritoneal fat plains, thence down the omenta and around the parietal peritoneum. In a case of acute pancreatitis, rupture of the pancreas or other obstructive lesion which permits the escape of pancreatic juice, the fat necrosis may be prevented by the application of the quarantine as shown in Fig. 11. The wicks in this case are arranged around the lesion in the pancreas and introduced from abdominal incision through the gastro-colic omentum. The rubber tissue in this case is made to entirely surround the gauze wicks.

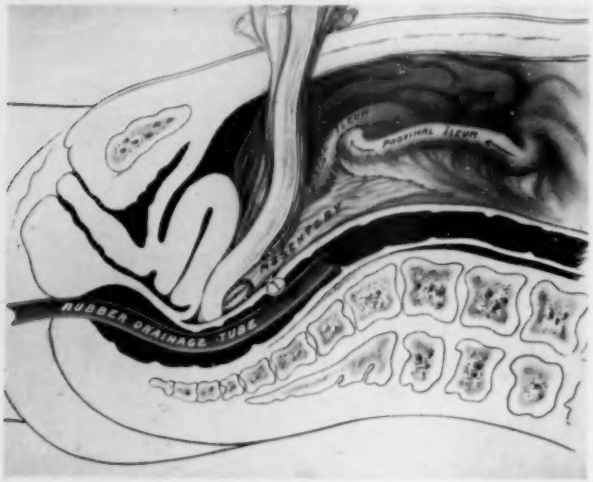

FIG. 15.—Repair of hole in pelvic colon in presence of a pelvic abscess.

Another indication for the quarantine is found in the case of necrotic bowel in which the patient is too far gone to permit of a radical operation and in which the abdomen is filled with septic, foul-smelling fluid as is often encountered in strangulated hernia.

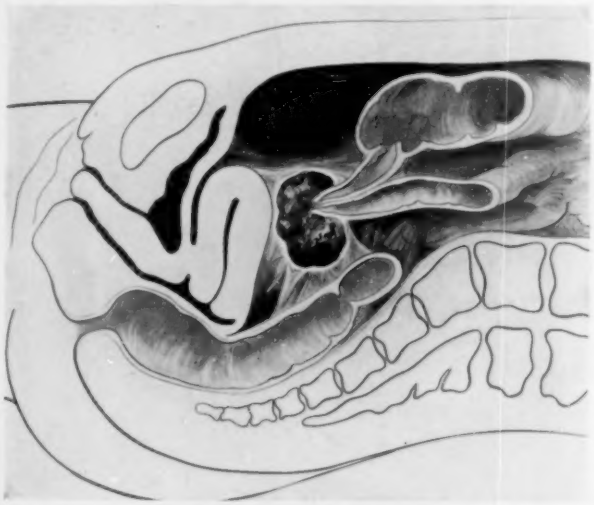

FIG. 16.—A perforated knuckle of ileum emptying into and discharging from a large pelvic abscess.

Still another indication is seen when the bowel is opened in the presence of an abscess such as is often encountered in pelvic operations. A striking instance is seen in the following case: A patient had been operated upon in a distant city for an unusual pelvic tumor. In a few months the growth returned in the form of a cyst. In removing it, the sigmoid was torn entirely in two. It was sewed but broke down. The two ends separated. A large abscess formed in

the lower end of the abdomen and broke out through the lower end of the incision. Through this opening, pus, fecal matter and a gelatinous substance, characteristic of the tumor which was present, all discharged. (Fig. 12.) Patient was in almost a moribund condition. Transverse colon was brought through an abdominal incision under local anæsthesia and a day later was opened to side track the fecal current. After a few days, a slight improvement occurred, but the improvement was not satisfactory. The patient was still in a very serious condition. The abdomen was again opened. The abscess wall and the cyst wall were removed. The ends of the intestine were sewed together, although not tightly. A rectal tube was placed in the rectum and passed beyond the incomplete anastomosis. The omentum was drawn down and tacked over the anastomosis, after which a quarantine of twenty-four wicks was placed across the pelvis to keep the intestines away from the infected area. The patient immediately began to improve. The wicks were removed in six days. The gutta percha a week later. A perfect anastomosis resulted. After this drainage wound had closed, the colostomy opening was closed and the continuity of the intestine was restored.

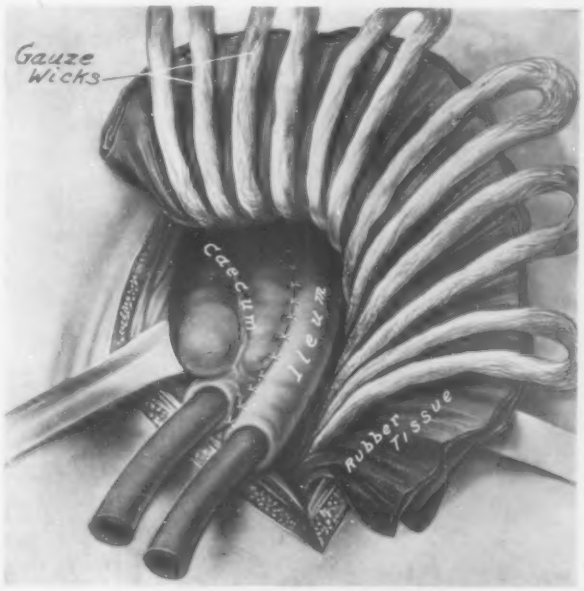

FIG. 17.—After isolating the two ends of ileum from the abscess, tubes are placed in the proximal and distal segments which are attached to the parietal peritoneum and surrounded by a quarantine. Used in case illustrated in Fig. 16 and is applicable in case of strangulated hernia.

In such an instance as where the colon is opened during the progress of an operation for a pelvic abscess, or in a case where the operation has been done previously, leaving a fecal fistula in the low pelvic colon, such an opening may be closed by bringing omentum down over it in the same manner. (See Fig. 13.)

If, in such a case, it is found that the omentum has been destroyed at the previous operation, or at least cannot be brought down into the pelvis to cover the opening, the emergency may be met as was done in one case as follows: The ileum was severed about two feet above the ileo-cæcal valve. The distal end was turned in and closed by several layers of sutures. The proximal end was implanted into the side of the distal segment of ileum mid-

way between its end and the ileo-cæcal valve by an end-to-side anastomosis. (Fig. 14.) The mesentery was cut and the edge of the proximal segment was sewed to the upper surface of the distal mesentery, the stump with its mesentery was brought down into the pelvis and the mesentery was tacked down over the opening in the colon. The quarantine pack was then placed across the pelvis, tube was placed in the rectum, and the closure of the fistula was completed just as if we had used the omentum. (Fig. 15.) Figure 16 shows a case for the application of the principle where an intestine has become gangrenous and has sloughed and in which the infection is too widespread and the patient is too sick to withstand an intestinal anastomosis. The sloughing of the bowel in this instance had taken place gradually and an abscess had formed. A part of the intestinal contents after going into the abscess worked down through the distal segment. The patient was entirely unable to stand a major operation. The abscess wall was enucleated. The severed ends of the ileum were liberated. A tube was passed into the severed proximal end of the ileum while another was passed into the distal ileum and cæcum, forming a double-barrel shotgun effect. The intestines were then tacked to the parietal peritoneum on one side of the wound. A quarantine wall was placed entirely around the infected area and around these intestinal loops. (Fig. 17.) In a few days, tubes came away and wicks were removed. A clamp was used to cut the two intestines together by the Mikulicz plan. Later the rubber tissue was removed, the wound gradually healed, leaving a fecal fistula which was later closed by the extraperitoneal method first described in the ANNALS OF SURGERY, June, 1908. This application may appropriately be made for advanced strangulated hernia.

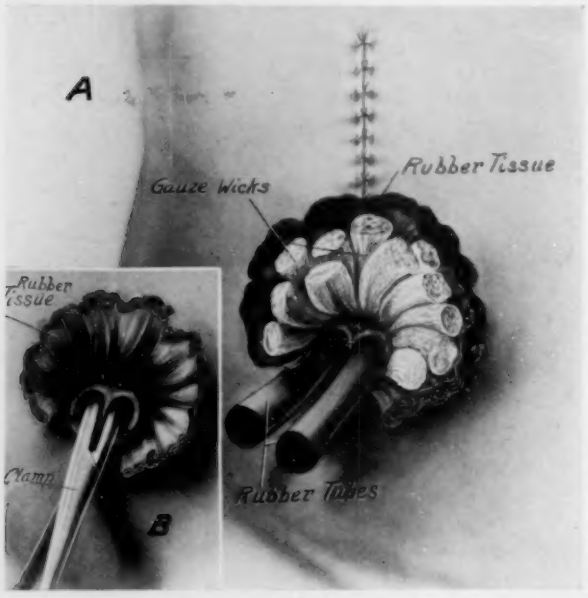

FIG. 18.—Quarantine surrounding septic area and the two open intestinal ends. Insert shows cutting the lumina of the two intestines together by a clamp, using Mikulicz plan. At a later date when the rubber tissue is removed, an ordinary fecal fistula remains.

A fourth type of case in which the quarantine is applicable is seen in extensive pelvic disease in which large areas of peritoneum have been removed. The patient is in a depleted condition—oozing is taking place in the œdematous tissues which cannot be stopped with forceps, and it is necessary to control with pack. Or it may be that in such a case there is added

to the bleeding, infection. The quarantine pack is ideal in such a case for it not only stops the bleeding but gives ample drainage and the smooth rubber tissue bars coils of intestine from the traumatized field where they might be ensnared in a mass of adhesions.

I think one of the most satisfactory uses for the quarantine pack is found in the case of extensive adhesion producing inconvenience and making the patient an invalid. Such cases are sometimes found in certain individuals who have especially strong protective qualities, in whom the abdomen has been open many times. Adhesions have been cut and futile attempts have been made to repair the raw surfaces with the result that the adhesions were firmer than at the previous operation. In such a case if the adhesions are severed and a quarantine pack is thrown around the pelvic organs and the rubber tissue is made to cover practically all the pelvic cavity, the patient will be entirely relieved of adhesions in nearly all cases. As a matter of fact, I do not recall a single instance in which I have been called upon to reoperate for adhesions after the quarantine pack has been used in this manner. A similar indication is found in the neighborhood of the gall-bladder after the gall-bladder has been removed and the stomach has firmly adhered to the under surface of the liver and gall-bladder bed. Such a condition is likely to produce obstructive symptoms requiring extensive dissection to separate the stomach and pylorus from the under surface of the liver. While in such a case, the omentum drawn across the stomach is usually sufficient to prevent recurrence, it is well to remember that a quarantine inserted between the under surface of the liver and the stomach (with rubber tissue on the stomach side) produces equally good results.

The wicks of the quarantine are removed under primary light gas anæsthesia six or seven days after they have been placed. The rubber tissue is removed without anæsthesia fourteen days after operation. Nothing is reinserted.

ABDOMINAL INCISIONS TREATED BY THE "OPEN METHOD"

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and

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The importance of the simpler phases of surgical technic is apt to be obscured by the pardonable enthusiasm of the profession to discuss complex and profound topics. In this connection it might be noted that there is very little to be gained by perfecting the method of performing intestinal resections if we neglect to learn how to open and close the abdomen and treat the resulting wound effectively. Believing that there is still considerable light to be thrown upon this apparently simple subject, we offer the following résumé of the healing of a series of 112 abdominal incisions made by the authors at the Fifth Avenue Hospital during the year 1926.

In order that we may make our topic as simple as possible, we confine our discussion to wounds made for the performance of abdominal operations during the course of which it was not found necessary to drain the peritoneal cavity. We believe it unwise to discuss drained and undrained wounds at the same time. The mechanical factors involved are too diverse to permit generalization.

To simplify the study of the behavior of these wounds, a special wound record was prepared, a facsimile of which will be found in Table I. This wound record contains certain features which will bear consideration. In common with all such records it carries the name of the patient and operator, together with the name of the operation and date. In the following points it differs from any similar records which we have seen.

There is a space for listing type of skin preparation. The chemical and mechanical means which are employed should be described in detail. There is probably no factor which has as strong an influence upon wound behavior as does relative skin sterility. It is obvious that if a certain type of skin preparation is producing relative asepsis, just what that skin preparation is and how it is applied must be stated.

Besides calling for the name of the incision used, there is a space for the name of the surgeon making the incision.

In recording the facts about wound closure, a line is allotted to each layer of abdominal wall on which is stated the kind of suture material used. The terms absorbable and non-absorbable we do not consider sufficient, believing that the size of material as well as the type of its preparation and the name of its maker should be given. It should also be noted that there is a space for entering the name of the individual placing each layer of sutures. This is important because in those clinics in which it is customary for the operator to turn over closure of the abdominal wall to an assistant, such a procedure is

certainly a variable factor when considering the subsequent behavior of the wound.

There is a space for listing non-absorbable retention sutures in which should be given the name of the material, its preparation, size and maker.

Definite statement as to the type of antiseptic, if any, applied to the skin

TABLE I

WOUND RECORD

Date of Operation.....
Patient's Name .....Room number.....
Name of Operation .....
Name of Operator .....Assistants.....
Skin Preparation .....
Type of Incision .....Made by.....
Closure:—peritoneum .....Made by.....
posterior sheath of rectus .....Made by.....
rectus muscle .....Made by.....
anterior sheath of rectus .....Made by.....
fat .....Made by.....
skin .....Made by.....
Tension sutures? .....How placed?.....
Drainage .....
Antiseptic applied to skin after closure? .....
Type of dressing .....
Were there any observed breaks in technique? .....
Is there any reason why this wound should not heal by first intention?.....

1st day	6th day	11th day .....
2d day	7th day	12th day .....
3d day	8th day	13th day .....
4th day	9th day	14th day .....
5th day	10th day	15th day .....

Abbreviations. P—pus. S—serum. B—blood. G—gas. √—Uncomplicated healing. Sep—separation of skin.

Pathologist's Report:

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after closure, should be made. The same conditions which applied in regard to pre-operative skin sterilization hold good after the incision is closed.

There is a place for the description of the drainage (in cases under discussion, the answer was always "none").

An expression of opinion by operator as to whether there were any apparent breaks in technic should be made. If, during the course of operation, a glove has been torn or some other obvious possibility of infection occurred and the wound subsequently becomes infected, this information will be of great value.

There should be expression of opinion on part of operator as to whether there will be any complications during the course of the wound healing. This permits the notation of marked atrophy of abdominal musculature, consti-

tutional handicaps of the patient such as anæmia, cachexia, etc., and the presence or absence of marked jaundice. In the lower portion of the sheet are spaces for notation of condition of wound for fifteen days, which are filled in daily and initialed by the surgeon making rounds.

At the bottom is a space for any pathological reports in the case of infection. This feature we have practically discarded, believing that under the usual conditions of obtaining smears from infected wounds, the resultant growth cannot be proven to have come from within the anterior abdominal wall by culture alone, since the possibility of contamination with bacteria always present on the skin is not excluded. The following case might be taken as an instance. In a certain incision on the sixth day, a fluctuating mass was felt under the skin. There was no rise in temperature, pulse or respiration, no tenderness or other sign of local inflammatory process, and twenty-four hours later about a drachm of clear yellow serum was expressed from a small separation of the wound edges. The instant that the serum touched the skin it came in contact with bacteria in the surrounding pores and follicles and a culture taken at this time naturally showed the presence of bacteria. This, however, is not conclusive proof that the wound was infected. It is our belief that unless the material for culture is taken before there is any chance of it being contaminated by contact with the skin—and such circumstances are obviously impossible, unless taken by aspirating with a sterile syringe—positive growths from wound fluids do not prove wound contamination at operation. However, if a fluctuating mass forms in the incision, with signs of local inflammatory reaction and rise in pulse and temperature, and the fluid upon liberation, either artificially or spontaneously, proves to be pus when it first appears, there can be no question of the fact that the wound is infected and should be classified as such.

This wound record might be criticized as too complicated, but we do not see how any part of it could be deleted and permit a scientific study of wound behavior. There can be no argument about the fact that wounds containing chromic catgut frequently develop collections of serum which when expressed, contain short pieces of suture material which have become foreign bodies, while wounds containing only plain catgut are not subject to this complication as frequently. Hence it is obvious that in reviewing a series of wounds, the preparation of the catgut used should be definitely stated. If the profession is to learn anything about the value of different brands of catgut in the market, a statement of the brand used must be made.

Notwithstanding, it has been our experience that discussions of wound closure seldom, if ever, take cognizance of these features which are so important that a discussion of wound behavior must include their accurate description.

There are many ways of classifying wound healing. The following method is offered as simple but inclusive. We divide wounds into four classes—A, B, C and D.

Class A. During the healing of the wound there is no discharge of

blood, serum, gas or pus. It is to be understood that in the open treatment the oozing of a few drops of blood from the incision edges during the hour or so post-operative is not considered sufficient to take it out of Class A. Likewise if, when skin plasters are taken off there is a little bleeding when the scab is pulled off, it is not considered a complication.

Class B. During the healing of the wound there have been no complications other than (1) discharge of a small amount of serum, in the absence of any signs of infective reaction in the wound, such discharge of serum lasting no longer than seventy-two hours and in no way hindering the recovery of the patient; (2) the release of a small amount of air from an artificial vent made at the wound end or, (3) the discharge of a small uninfected blood clot.

FIG. 1.—Showing dressings, with arrangement of bed clothing to allow desired exposure of wound.

Class C. During the healing of the wound there is at any time discharge of pus, the discharge, however, not lasting beyond the tenth day post-operative and in no way effecting the recovery of the patient.

Class D. During the healing of the wound any complication arises which affects the recovery of patient, such as extensive infections lasting beyond the tenth day, or the spontaneous wound rupture.

These classifications are simple and we believe need no comment.

For purposes of brevity we do not discuss at this time the effect of the variable factors. We are submitting this series to support our contention that wounds treated by the "open" method yield exceptionally high healing average. The wounds under discussion have the following features in common. 1. In each instance, before operation, the skin was prepared by a dry shave, following the usual bath, and at the time of operation the area was scrubbed with ether and then an antiseptic applied—the antiseptic being either 2 per cent. iodine in carbon tetrachloride or a mixture of 5 per cent. methylene blue and 5 per cent. gentian violet in 50 per cent. alcohol. 2. Only catgut was used in the closures. 3. The peritoneal layer was closed with No. 1 plain catgut. 4. The fat layer was seldom, if ever, sutured. 5. The skin was closed with continuous No. 0 plain subcutaneous suture. 6. The skin edges were approximated by isinglass court plaster. 7. After operation the wounds were all treated in the following manner.

While the patient was still on the table the wound was thoroughly dried

by blowing over it hot air from a portable electric hair dryer. While on the stretcher returning to his room, a sterile towel was placed over the incision. When the patient was in his own bed, the wound was further dried by exposing it to the air. To accomplish this without endangering him from exposure, the "double bed" is used, as shown in Fig. 1. When the wound is dry the night clothes are pulled down directly over the incision and no further dressing is applied to the skin. At no time were any gauze, towels, plaster (other than isinglass court plaster), cotton or any other type of dressing applied.

The following chart (Table II) explains itself:

TABLE II

WOUND SHEET SUMMARY FOR YEAR 1926

Total number of incisions	112	
Total Pfannenstiel's	56	
(Transverse, supra-pubic, pelvic approach).[1]		
Total McBurney's	23	
(Muscle-splitting, appendiceal approach).[2]		
Total Kocher's	23	
(Transverse, upper abdominal approach).[3]		
Total miscellaneous	10	
Classification of wound healing:		
		Percentage.
Total A's	98	A's—87.5
Total B's	11	B's— 9.8
Total C's	3	C's— 2.7
Total D's	0	D's— 0
Total A's in Pfannenstiel incisions	52—46.4	
in McBurney incisions	21—18.8	
in Kocher incisions	16—14.3	
in Miscellaneous incisions	9— 8.0	
Total B's in Pfannenstiel incisions	5— 4.4	
in McBurney incisions	1— .9	
in Kocher incisions	4— 3.6	
in Miscellaneous incisions	1— .9	
Total C's in Pfannenstiel incisions		
in McBurney incisions		
in Kocher incisions	3— 2.7	
in Miscellaneous incisions		
Total D's in all incisions	0	

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SURGICAL ANATOMY OF THE RECURRENT LARYNGEAL NERVE WITH ESPECIAL REFERENCE TO THYROID SURGERY

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from the Cleveland Clinic

The surgeon who deals with pathological conditions of the neck, particularly of the thyroid, encounters one structure of vital importance, *i.e.*, the recurrent laryngeal nerve. Only those who have seen injuries of the nerve so severe as to require tracheotomy, and have realized that the impairment of the voice might be permanent, can appreciate its vital importance.

In reviewing the textbooks on anatomy and the pictures which illustrate the location of the recurrent laryngeal nerve, one is immediately impressed with the fact that opinions differ considerably as to the normal position of the nerve. Thus one author describes the nerve as lying directly in the tracheo-œsophageal groove, while others describe it as lying in a lateral position. For this reason I carried out a series of dissections in an attempt to enlighten myself as to the real position of this nerve.

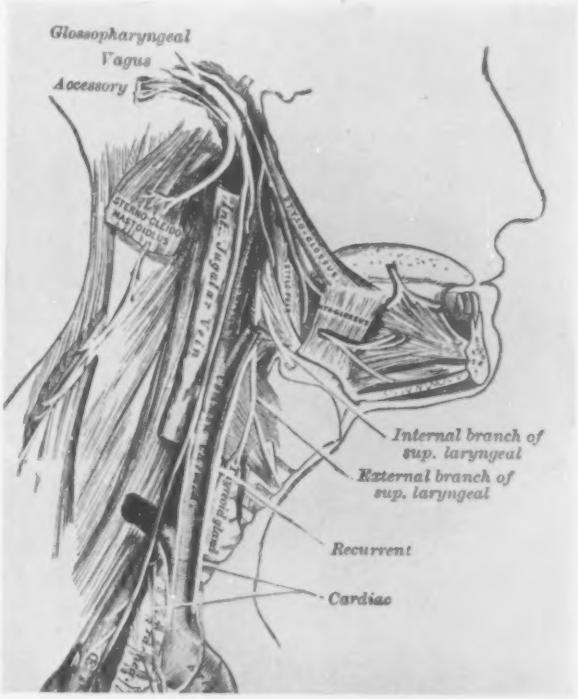

Fig. 1.—The recurrent laryngeal nerve and superior laryngeal nerve. (From Gray: *Anatomy of the Human Body*, 1918, 20th Ed., p. 909.)

Let us consider first the *inferior recurrent laryngeal* nerve. Normally the tracks followed by the right and left nerves vary, so they will be discussed individually.

The *right nerve* arises in front of the subclavian artery, passes around the artery, and then passes obliquely upward to the side of the trachea. (Figs. 1–4.) Usually it passes behind the inferior thyroid artery (Figs. 5 and 6), however, occasionally it is seen in front of this vessel, and in cases in which a large adenoma of the thyroid is present at the lower pole the nerve may

be displaced anteriorly for a considerable distance. It then ascends in the tracheo-œsophageal groove. (Figs. 7–9.) About three-fourths of an inch before it enters the larynx it divides into two constant fibres. One of these divisions anastomoses with the internal laryngeal nerve which either pierces the inferior constrictor or passes beneath its inferior border, while the other branch passes into the larynx behind the articulation of the cricoid and the inferior corner of the thyroid cartilage. (Fig. 10.) This fibre supplies the muscles of the larynx, with the exception of the cricothyroid muscle.

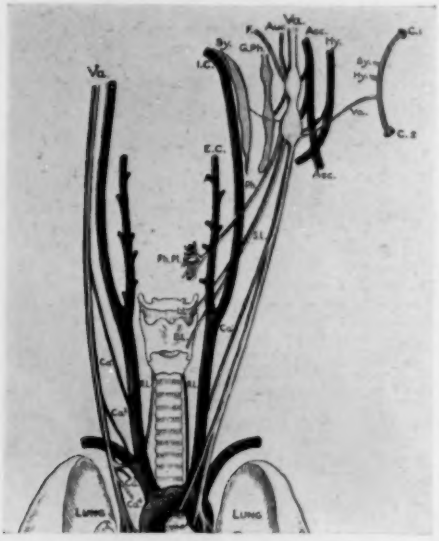

FIG. 2.—The distribution of the vagus nerve showing the right and left recurrent nerves—R. L. (From Cunningham: *Text-Book of Anatomy*, 1918, 5th Ed., p. 787.)

The nerve gives off several small but important branches:

1. The cardiac branches, which end in the deep cardiac plexus. These branches arise as the nerve hooks around the subclavian artery.

2. The tracheal branches. As the nerve passes upward in the tracheo-œsophageal groove many small fibres are distributed to the trachea. (Fig. 11.) These nerves are important and we shall discuss them in detail later.

3. The muscular branches. As the nerve passes upward these branches are seen to run to the anterior lateral wall of the œsophagus.

4. Fibres which extend to the inferior constrictor of the larynx.

5. Two more constantly present fibres, arising about half an inch before the recurrent nerve enters the larynx. One of these branches passes to the œsophagus, near the junction of the pharynx with the œsophagus, and the other to the thyroid gland at its tracheal attachment.

The principal difference in the locations of the left and right nerves is in their origin. While, as stated above, the right nerve arises in front of the subclavian artery, the *left nerve* arises from the vagus as it passes over the arch of the aorta. It then winds around the arch just laterally to the ligamentum arteriosum, and passes upward along the tracheo-œsophageal groove. (Figs. 12 and 13.) The distribution of branches is similar to that on the right side (Fig. 13), and although the statement has been made that the branches are more abundant on the left side than on the right, this has not been noted in my dissections. (Figs. 14 and 15.) Another difference which was noted was that in the tracheal region the right nerve lies farther to the front than does the left. (Figs. 16 and 17.) The two nerves terminate in a similar way.

The *superior laryngeal nerve* arises from the ganglion nodosum. It

receives a branch from the sympathetic nerve system through the superior cervical ganglion, and passes downward beneath the external and internal carotid arteries toward the lower portion of the thyroid cartilage, where it divides into the two terminal branches, the external and the internal laryngeal nerves.

The *external laryngeal nerve* passes downward beneath the sternothyroid muscle and supplies the inferior constrictor muscle of the pharynx and the cricothyroid muscle, in which it terminates. It also communicates with the superior cardiac nerve.

The *internal branch* passes through the hyothyroid membrane with the superior laryngeal artery and innervates the mucous membrane of the larynx. Branches also extend upward to the epiglottis and the base of the tongue. A communication between this internal branch and a terminal branch of the inferior recurrent nerve occurs after the latter has passed upward under the lamina of the thyroid cartilages.

FIG. 3.—The recurrent laryngeal nerve. Anterior-posterior view. (1) Retracted left lobe of thyroid. (2) Left recurrent laryngeal nerve. (3) Retracted right lobe of thyroid. (4) Right recurrent laryngeal nerve.

Let us now consider the complications which result from injuries to the nerve. First of all, I want to call your attention to the fact that such an injury may occur even when the nerve has not been actually clamped with a hæmostat, as mere traction on the gland, especially at the superior pole, may tear loose the terminal branches of the inferior recurrent nerve.

As a routine procedure in the Cleveland Clinic pre-operative and post-operative examinations of the larynx are made by a member of the otolaryngological department. This enables us to check accurately the number of paralyses which are due to injury of the nerve and to correlate the operative result with the clinical findings.

FIG. 4.—The recurrent laryngeal nerve. Anterio: terior view. (1) Left recurrent laryngeal nerve. (2) Right recu. at laryngeal nerve. (3) Left inferior thyroid artery. (5) Reflecte. right lobe of thyroid.

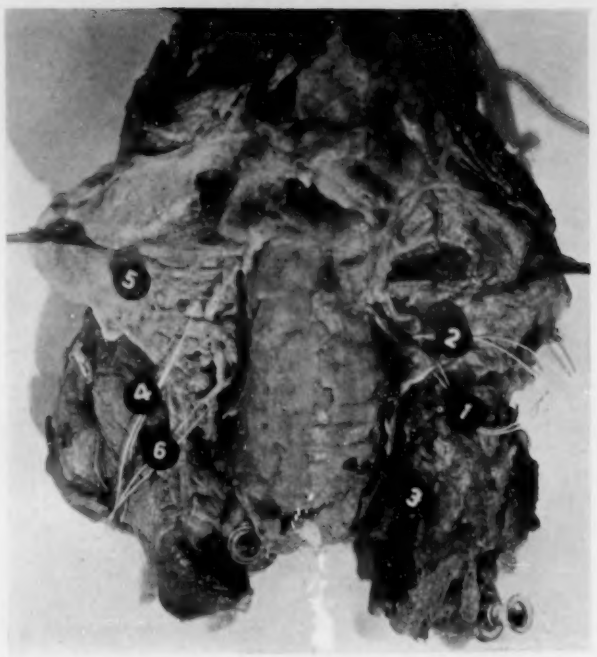

FIG. 5.—The recurrent laryngeal nerve. Anterior-posterior view. (1) Left inferior thyroid artery. (2) Left recurrent nerve passing under artery. (3) Left recurrent nerve. (4) Right inferior thyroid artery. (5) Retracted lateral lobe of thyroid. (6) Right recurrent nerve passing under artery.

FIG. 6.—The recurrent laryngeal nerve. Anterior-posterior view. Note the nerve passing under the artery.

FIG. 7.—The recurrent laryngeal nerve. Anterior-posterior view. Note the nerve passing up toward the tracheo-esophageal groove, anterior to the inferior thyroid artery.

FIG. 8.—The recurrent laryngeal nerve. Lateral view. (1) Terminal branch of the left nerve passing into the larynx. (2) Division of the nerve passing into the œsophagus. (3) The trachea. (4) The œsophagus. (5) The left nerve. (6) The tracheo-œsophageal groove.

To understand the course of the dyspnœa and hoarseness which characterize these injuries we must appreciate what happens to the cords when the nerve is injured. As the result of the injury the intrinsic muscles of the larynx are paralyzed, *i.e.*, the constrictors, the dilators and the tensors. Abductor paralysis is most frequently seen, as the abductor muscles receive the predominating fibres of the recurrent nerve. A laryngoscopic examination shows that, as the cord becomes flaccid and approaches the midline, the size of the lumen of the larynx is diminished. This causes the stridor and the dyspnœa which occur during the operation. Following this, the tonus of the cord is lost, the epiglottic chink is enlarged, and the difficulty in breathing becomes less noticeable. This may be called the cadaveric position of the cord. If it is not necessary to perform a tracheotomy before this second stage is reached, it may not be required at all.

Injury of one nerve does not always give clinical symptoms. In fact, in seventy per cent. of the cases in which a laryngeal examination reveals a unilateral abductor paralysis, the patients have been unaware of any difficulty. Compensation by the other cord has evidently taken place immediately. In cases in which a large adenomatous goitre is present, a pre-operative examination sometimes reveals a paralysis of one cord

FIG. 9.—The recurrent laryngeal nerve. Anterior-posterior view. Note the right nerve passing up the tracheo-œsophageal groove.

which has given rise to no symptoms. Usually a bilateral injury of the nerve, and occasionally also a unilateral paralysis, necessitates a tracheotomy, or the patient is unable to speak above a whisper. In very few cases, however, is a permanent tracheotomy necessary; usually the tube can be removed in one to three days and the wound allowed to heal.

A second post-operative complication which may develop is tracheitis. This can usually be anticipated during the operation, for if the trachea is denuded of its fascial covering, especially on its lateral aspect, a tracheitis invariably develops. It is undoubtedly due to injury of the trachea and to the removal of the nerve filaments which pass from the recurrent laryngeal nerve along the anterior lateral margin of the trachea. For this reason a small amount of tissue should be left as a covering for the trachea.

FIG. 10.—The recurrent laryngeal nerve. Lateral view. (1) Terminal branch of the left nerve passing into the larynx. (2) Division of the nerve passing into the œsophagus. (3) The trachea. (4) The œsophagus. (5) The left nerve. (6) The tracheo-œsophageal groove.

FIG. 11.—The recurrent laryngeal nerve. (Diagram) Lateral view. Note the distribution of the small fibres to the trachea.

Occasionally difficulty in swallowing ensues after operation. This seems to be due to an impairment of the function of the epiglottis and I believe it can be explained by the fact that a communication exists between the superior laryngeal nerve and the inferior recurrent nerve, a terminal filament of the latter connecting with the internal laryngeal nerve which arises from the former; moreover branches from the internal branch of the superior laryngeal nerve pass to the epiglottis, so that if the recurrent nerve is injured the function of the epiglottis may be impaired.

Stridor, which may be only temporary or may necessitate a tracheotomy,

FIG. 13.—The recurrent laryngeal nerve. Lateral view. (1) The left nerve. (2) The left lobe of the thyroid. (3) The trachea. (4) The tracheo-œsophageal groove.

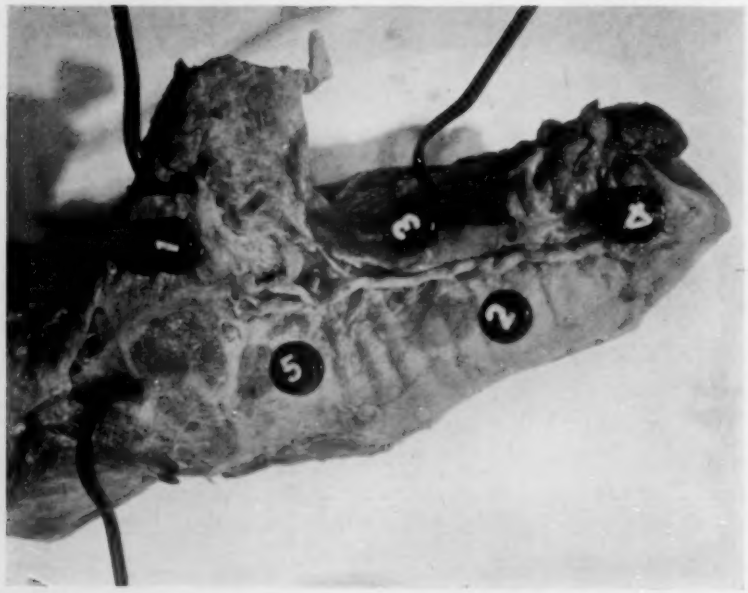

FIG. 12.—The recurrent laryngeal nerve. Lateral view. (1) Retracted left lobe of the thyroid. (2) The trachea. (3) The left nerve. (4) The tracheo-œsophageal groove. (5) A branch of the nerve passing to the trachea.

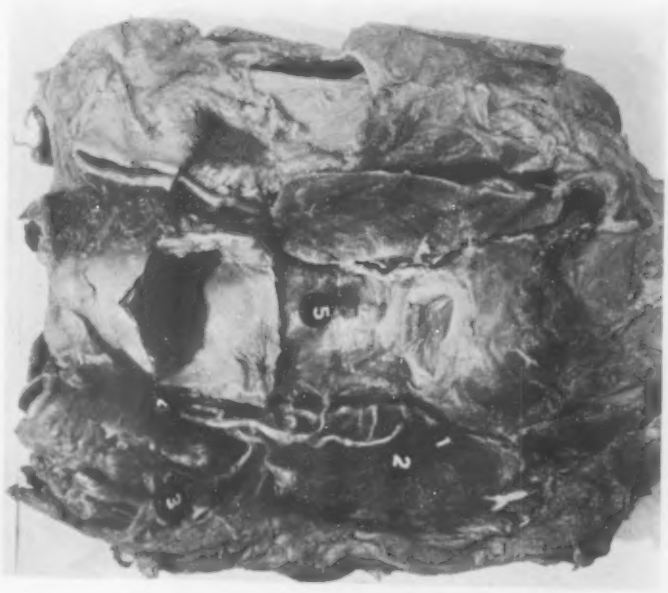

FIG. 14.—The recurrent laryngeal nerve. Anterior-posterior view. (1) Division of the nerve passing to the larynx. (2) Division of the nerve passing to the œsophagus. (3) The inferior thyroid artery. (4) The left nerve. (5) The œsophagus.

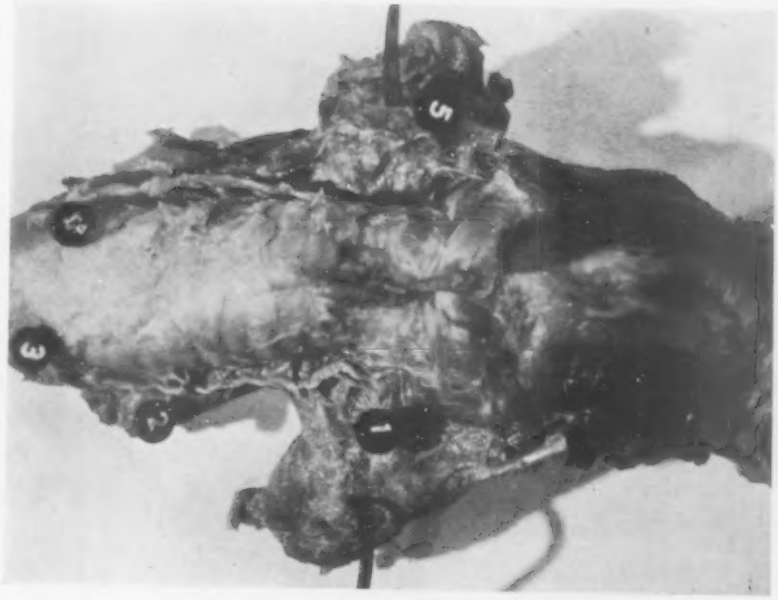

FIG. 15.—The recurrent laryngeal nerve. Anterior-posterior view. (1) Retracted left lobe of thyroid. (2) The left nerve with filament passing to the trachea and the œsophagus. (3) The left nerve. (4) The right nerve. (5) Retracted right lobe of the thyroid.

FIG. 16.—The recurrent laryngeal nerve. Anterior-posterior view. (1) The left nerve. (2) The right nerve. (3) The left inferior thyroid artery. (4) The right inferior thyroid artery. (5) Retracted right lobe of the thyroid. (6) The carotid artery. Note that the right nerve lies farther to the front than does the left.

FIG. 17.—The recurrent laryngeal nerve. Anterior-posterior view. Note that the right nerve lies farther to the front than does the left, which has been displaced upward.

may result from injury of the recurrent nerves. When this complication follows operation the patient is watched constantly and is never left alone. First of all the cords are examined to ascertain whether the paralysis is unilateral or bilateral. If the stridor continues, the pulse and respiration remain rapid, the accessory muscles of respiration are over-active, and the patient complains of the effort involved in breathing, a low transverse tracheotomy is performed *provided cyanosis is not present.* Occasionally compensation occurs in from four to six hours, in which case the tube can be removed

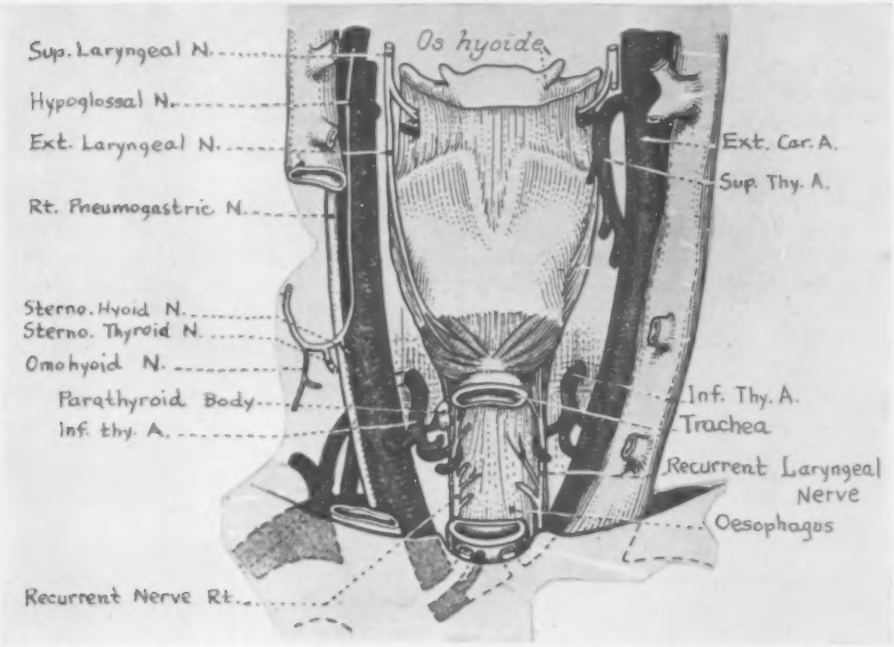

FIG. 18.—Relation of the right recurrent laryngeal to the hypoglossal nerve. (From Pauchet and Dupret: *L'Anatomie en Poche*, 1926, Plate 133).

and the trachea reapproximated with one chromic catgut, the patient making an uneventful recovery.

If the damage is permanent, a permanent tracheotomy tube may be worn, or a plastic operation on the nerve may be attempted. In August, 1926, Frazier and Mosser [1] reported the results of anastomosis between the descendens noni branch of the hypoglossal nerve and the recurrent laryngeal nerve. (Fig. 18.) Improvement was noted in 60 per cent. of their cases. Anastomosis with the phrenic nerve has also been accomplished.

Operations for the relief of injury of the laryngeal nerves have been described by Hoessly,[2] Schmerz,[3] Guttman [4] and others. In 1915 Payr [5] described a plastic operation on the larynx for unilateral nerve injury and Schmieden [6] has recently reported a very successful result following such an operation.

CONCLUSIONS

1. The prevention of injuries of the recurrent laryngeal nerve demands an accurate understanding of the anatomical relations of the nerve on the part of everyone who deals with surgery of the larynx or of the thyroid gland; (2) the fact that anomalies of the nerve may occur must constantly be kept in mind; (3) the patient who has suffered an injury to the recurrent nerve must always be kept under close observation in order to prevent an unfortunate sequel.

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CERVICAL RIB*

A METHOD OF ANTERIOR APPROACH FOR RELIEF OF SYMPTOMS BY DIVISION OF THE SCALENUS ANTICUS

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INTRODUCTION

Until recently the symptoms that accompany cervical rib have been attributed entirely to the presence of this anomaly. The relations of the scalenus anticus muscle to the anomalous rib have been defined anatomically, but they have not been considered surgically. We shall attempt to describe the anatomic distortion produced by a cervical rib directly and indirectly, and to justify anatomically and physiologically, as well as by presentation of results, a radical modification and simplification of previous methods of correcting that distortion and relieving symptoms.

HISTORY

Galen and Vesalius were the first to describe a cervical rib in detail. A cervical rib is a supernumerary rib, springing from one of the cervical vertebræ, usually the seventh, rarely the sixth, and very rarely the fifth. Helkiah Crooke, in his mikrocosmographia of 1651, mentions Bauhin finding thirteen ribs on each side at necropsy. Hunauld, the pioneer of our present conception, published his article in 1743. In 1818 A. Cooper was treating symptoms of cervical ribs medically with some success. Pilling reported 139 necropsy cases of cervical rib in 1860. In 1861 Coote performed the first operation and relieved the symptoms. Planet reports the second operation (by Perier in 1890); all symptoms were immediately cured. Fischer in 1892 operated on the third patient with success. Operation had been performed in eight cases by 1895.[25] In 1906 Keen reviewed all the cases in which operation had been performed to that time, numbering forty-two.

EMBRYOLOGY

Jones[20] attributes the embryologic formation of supernumerary ribs to a conflict between forming plexuses and ribs. The snake, without neck, waist, arms or legs, possesses two ribs for each vertebra with corresponding separate segmental nerves. In higher forms the limb buds appear as precursors to arms and legs. At first these buds cover several vertebral segments the nerves from which grow into the buds. However, the diametric growth of the limb buds does not keep pace with the longitudinal growth of the

* Read before the Western Surgical Association, October 14, 1926.

vertebral column and soon segmental nerves have to pursue an oblique course to enter the buds. Then begins the conflict between the obliquely running nerves and the newly forming ribs. The embryonic nerve trunks are far larger in proportion to the vertebræ and ribs of the embryo, than in the fully developed animal. The obliquely running nerves normally impede the growth of the ribs, so discouraging them that they merely form vertebral processes. Todd [39] states that ribs are normally present in the fœtus in articulation with vertebræ above the eighth, and that after birth they are present only as transverse processes of the cervical vertebræ.

FIG. 1.—Surgical specimens of cervical ribs, illustrating the different sizes and shapes under Gruber's classification. *a*, Group 2; *b*, Group 3; *c*, Group 4.

The extent of growth of a cervical rib is determined by the resistance of the nerve in its path. Jones asserts that anomalies in the arrangement of rib plexuses are primary and not secondary to rib formation. In a normal brachial plexus the first dorsal nerve may vary in its contribution from a mere thread to a bulky cord, and Eisler asserts that when a cervical rib is well developed the plexus either receives no contribution, or only a very small one, from the first dorsal nerve. Jones has found in cases of rudimentary first thoracic rib that the second dorsal nerve makes a considerable contribution to the brachial plexus. Todd believes that the vessels have equal importance with the nerves as causative factors in modifications of the upper end of the thorax.

ANATOMY

Comparative.—Many variations in the number of ribs and situation of limbs are to be found in the evolution from snake to lizard. Cervical ribs are normal in crocodiles.[11] The anthropoid ape has thirteen pairs of ribs. Adolphi found a dog with twenty-six ribs. Evolutionists assume that there is a tendency toward a shortening of the thorax, but there is no logical reason to be found for this. It is more probable that an increase or decrease from the normal number of ribs is anomalous.

Costal Anomalies in Man.—Man has normally twelve pairs of ribs. Todd classifies the various anomalies in three groups: (1) Anomalies of the lower end of the thorax with increase or decrease in number of ribs; (2) anomalies of the upper end of the thorax with increase or decrease in the number of ribs; (3) anomalies of the upper and lower ends of the thorax. He finds no evidence that associated anomalies at both ends of the thorax are compensatory.

Anomalies of the upper end of the thorax reported run from rudimentary first ribs to double cervical rib on the same side of which at least three authentic instances have been noted.[22] Gruber, of St. Petersburg, in 1869 classified cervical ribs in so complete a manner that his classification has never been improved. He divides them into four groups: (1) Slight degree, cervical rib reaching beyond the transverse process; (2) more advanced, cervical rib reaching beyond the transverse process either with a free end or touching the first rib; (3) almost complete, the connection with the cartilage of the first rib being formed by means of a distinct band or by the end of the long body of the cervical rib, and (4) complete, the rib having become complete and possessed of a true cartilage which unites with the cartilage of the first rib. (Figs. 1, 2 and 3.)

The complete cervical rib extends out laterally from the seventh lateral vertebral process for varying distances, then turns forward and downward between the scalenus anticus and scalenus medius muscles to meet the costal cartilage of the first rib. As the rib turns downward, the brachial plexus passes over it; then on its downward course the subclavian artery arches backward and laterally over it. Usually the scalenus anticus has attached itself to the cervical rib as the rib has pushed forward.[26] Still lateral to the rib and outside of the scalenus anticus, arches the subclavian vein, lower than the artery. The muscle lies between the vein and the cervical rib. Above the vein and nearly over the rib, passing transversely across the shoulder, are to be found two branches of the thyroid axis, the suprascapular and transverse cervical. Above these arteries, running in the same general direction, is the inferior belly of the omohyoid muscle. The phrenic nerve passes downward along the anterior surface of the scalenus anticus; within the costal arch, usually out of danger, lies the carotid sheath with the common carotid artery, internal jugular vein, and the vagus nerve. Over all these structures, laterally and anteriorly, runs the lower end of the sternocleidomastoid muscle with the external jugular vein passing down its postero-external border.

If the rib is incomplete with a ligamentous band to the first rib, the course is very much the same. However, the scalenus anticus is less likely to be attached to the ligament. Shorter ribs are likely to run more laterally. Halbertsma states that if the cervical rib is 5.6 cm. or more in length, the subclavian artery passes over it; if only 5.1 cm. or less, the artery passes over the first dorsal rib. The pleura lies directly under the cervical rib, the pleural cavity having been increased by one intercostal space.[12]

Murphy[27] states that if the rib is long enough the intercostal space between the cervical rib and the first dorsal rib is occupied by intercostal muscles and the vein and artery are exactly as in the thoracic intercostal spaces. Todd believes that the scalenes and intercostals are from the same muscle plane, forming two sheets, the inner forming the scalenus anticus and minimus, the outer the scalenus medius and posticus. These sheets of muscle are continued as the internal and external intercostals. The subdivisions of the scalenes are made by the passage of vessels and nerves. The course of

the subclavian artery through the scalenes corresponds to that of an intercostal artery through the chest-wall.

Occurrence of Cervical Rib With Neuropathies and Congenital Deformities.—Bassoe believes that cervical ribs belong to the so-called stigmas of degeneration and are features of an underlying neuropathic diathesis. Rosenhaupt states that cervical ribs are found in the progeny of persons with some physical degeneracy. At any rate, other congenital deformities are often associated with cervical ribs. Sherren knows of several instances in which cervical ribs have been removed for symptoms due to syringomyelia. Many cases of the two being associated have been known; Borchardt observed the first. Whitman in 1905 presented a case of congenital deformity with extreme torticollis. Agassiz reports a case of cervical rib associated with congenital absence of the right thumb and scaphoid. Ballantyne found a fœtus with cervical rib, imperforate vagina and distention of the uterus. McGavin mentions an associated bony mass at the first chondrosternal juncture. Renault and Romme had a case simulating cervical Pott's disease with malformation of the left foot, two nails on the second toe, atrophy of the fifth finger, two supplementary teeth, myopia and low intelligence. Poland's case was associated with club-foot. Copher reports a case of cervical rib without deformity of the scapula, but with a bony plate between the scapula and vertebræ, and spina bifida. Bassoe calls attention to Streissler's mention of cervical rib associated with spina bifida, harelip, crypto-orchidism, dislocated lens, club-foot, congenital lipoma, multiple sclerosis, syringomyelia, and muscular atrophy. No grounds can be found for Gaucher and Crouzon's opinion that cervical rib is an hereditary syphilitic dystrophy.

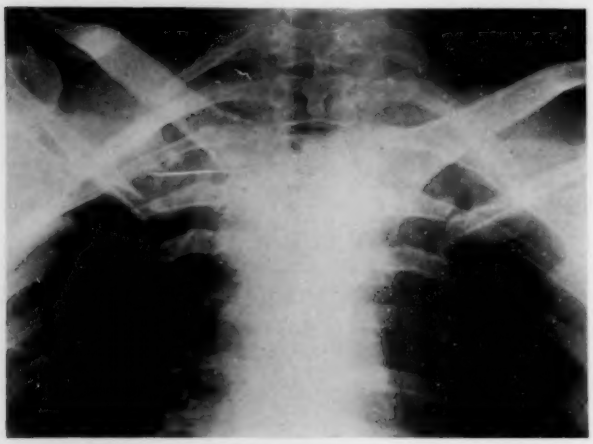

FIG. 2.—A completely formed right cervical rib, with symptoms, and an incompletely formed cervical rib on the left without symptoms.

Familial Occurrence.—Sufficient evidence is at hand to give credence to the statements of Bassoe and Rosenhaupt that cervical rib is an evidence of familial degeneracy. This is again borne out by Thompson's family of sixty-four individuals, representing five generations, in whom seven were affected with wasting of the hands, two of these examined by him having cervical ribs; by Wakeley's patient, whose sister also had cervical ribs, and by Weber's patient with cervical rib, whose brother and sister both had symptomless cervical ribs.

INCIDENCE

Murphy [28] quotes Borchardt's statement that the incidence of cervical rib is 0.03 per cent. Fischel and Prague give the necropsy incidence as 0.1 per cent.[13] Henderson in reviewing 80,000 routine examinations at the Mayo Clinic for five years ending in 1914, found thirty-one cases of cervical rib. Southam and Bythell examined röntgenograms of 2000 children more than fifteen months of age and found nine cases of cervical rib. In a study of 250 necropsy subjects, Todd found three cases of cervical rib and one of rudimentary first rib. Pilling in 1894 published an account of 139 cases of cervical rib found at necropsy; in three of these it had caused symptoms.

The occurrence of bilateral cervical rib lies between 67 and 80 per cent. of all cervical ribs according to different opinions.[5, 12, 18, 21, 28] In all of Sargent's twenty-nine cases bilateral abnormal ribs were present. Southam and Bythe found bilateral ribs in all of their cases. Murphy [28] states that but 30 per cent. of bilateral ribs that give symptoms give bilateral symptoms. Complete bilateral ribs are very rare.[5, 27] Up to 1907 Keen could find only two cases of complete bilateral ribs with bilateral symptoms. Among Pilling's 139 cases was one complete bilateral.

Two cervical ribs on the same side are extremely rare. Three authentic cases have been reported, one each by Beck, Ehrich and Struthers.

Side Involved.—The cervical rib is found more often on the left side, but symptoms are more common on the right side.[27] This is because of the greater use of the right arm, because the right plexus is in closer connection with the corresponding rib than the left, and because there is a greater drop of the right shoulder in the right-handed persons.[40] In Sargent's cases symptoms were usually on the side of the smaller rib.

SYMPTOMATOLOGY

Symptoms are much more common in women than in men. Evans gives the ratio of 3 to 1, Howell 14 to 2, Sargent 26 to 3, and Southam and Bythell 10 to 2. The preponderance of symptoms in women is hard to explain. Todd thinks that the greater movement of the upper part of the chest in women during respiration has much to do with it. Evans suggests that deformities in the neck are more noticeable in women. Childbirth and the greater susceptibility of women to the common causes of onset of symptoms, rapid loss of weight, chronic nervous exhaustion, and general ptosis, are certainly important factors as is the greater drooping of the shoulder girdle in women.

Onset of Symptoms.—Cervical ribs have been recognized in children by the presence of a tumor in the neck. Stiles had a patient eighteen months of age. A boy aged seven was brought to Barling with complaint of tumor. Murphy and Donaldson thought the most common age was from twelve to eighteen. Beck thought the symptoms were first manifested after the age of twenty. Evans between twenty and thirty. Howell reported ten of a series of sixteen to be under thirty. In a group reported by Sargent the

average age was thirty-eight and seven-tenths years, the youngest thirteen, the oldest sixty-two.

Characteristic Symptoms.—Many symptoms may be attributed to a cervical rib, especially by patients who have been informed of its presence, but the characteristic symptoms are one or more of the following: pain, atrophy, circulatory abnormalities and disturbance of sensation.

Pain is felt along the inner side of the arm, over the distribution of the internal cutaneous, the ulnar, and the median nerves and, occasionally, over the distribution of the entire brachial plexus. The pain may be sharp and lancinating and may be brought on by sudden rotation of the head or by a forceful, downward pull of the shoulder. Sometimes it is dull, aching, burning, and boring in character, and occurs during the latter part of the day, after the patient has been working for a time, especially in the case of housewives after sweeping, washing, or dusting. The pain may be associated by hyperæsthesia, paræsthesia, or anæsthesia, depending on the degree of involvement, affecting chiefly the distribution of the middle and lower cervical trunks. This is usually referred to as tingling, burning, and numbness along the inner side of the arm, hand, and fingers.

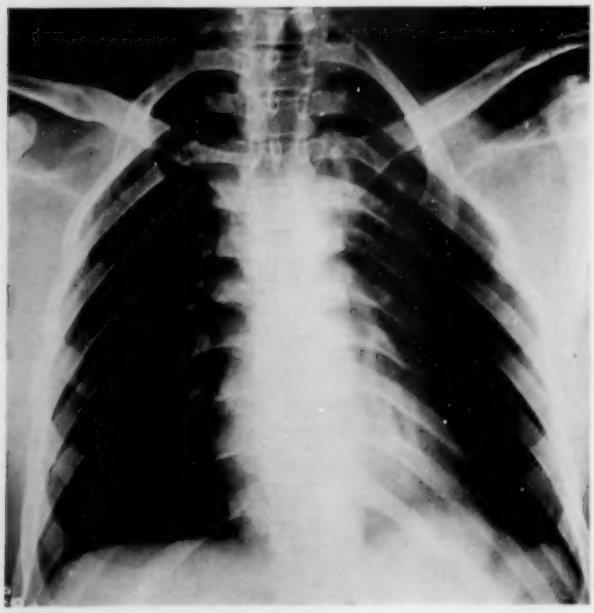

FIG. 3.—Completely formed bilateral cervical ribs with symptoms on both sides.

Atrophy is late to occur, and is rarely complete. In 1905, Thorburn reported two cases of atrophy of the intrinsic muscles of the hand associated with cervical rib. Jones [21] in reporting a series of fourteen cases of atrophy of the intrinsic muscles of the hand, found cervical ribs present in ten on Röntgen-ray examination. Wilson finds atrophy to be of two types: the median or partial thenar type and the ulnar type. In the former there is paralysis of the abductor pollicis, and the opponens pollicis, supplied from the seventh cervical nerve. The remaining thenar muscles are intact. The flexor brevis pollicis is also supplied from the median nerve, but probably from a different segment. The ulnar type ("main-en-griffe") in which there may be paralysis of all the muscles of the hand except the two just mentioned, is the result of injury of the eighth nerve.

Circulatory symptoms are rarely severe, but they may manifest them-

selves in a dusky hue of the arm and hand, as compared with the opposite upper extremity, associated with mild trophic changes in the tips of the fingers. Several cases have been reported in which gangrene of one or more fingers occurred. In this event obliteration of either the radial or the ulnar artery, or of both, usually occurs also. Diminution in volume of the radial pulse is common; the pulse can be decreased or obliterated by having the patient elevate the chin or rotate the head to the affected side while inspiring air. These symptoms vary in degree, according to the amount of pressure over the subclavian artery. Occasionally, the pulsating subclavian may be seen or palpated above the clavicle; occasionally, too, aneurism of the subclavian is said to occur, but we have not observed this in our series. The presence of Horner's syndrome has been described in cases of cervical rib.

The circulatory changes are caused by constriction of the subclavian artery or subclavian vein, obstruction of the radial and ulnar arteries by emboli from thrombosis at the site of constriction, or possibly by disturbance of the sympathetic innervation.

Horner's syndrome may be due to pressure and traction on the inferior cervical ganglion. Bernhard refers to Fischer's case of choking, and Dejerine reports a case with paræsthesia and definite loss of sensation over the distribution of the fifth and sixth cervical nerves which was relieved by operation. Similar relief was obtained by a patient of ours, a girl aged nineteen, with an exceedingly long neck and a marked downward course of the brachial plexus, which resulted in mesial displacement of the brachial plexus to the lateral edge of the cervical rib and subjected the entire brachial plexus to trauma by the scalenus anticus muscle. Evans believes that a short rib may lie close to the carotid sheath and produce disturbance of the vagus and of the recurrent laryngeal nerve. In one of the cases in our series there was a reflex cough every ten or fifteen seconds; this we relieved by dividing an anomalous twig from the phrenic nerve. The brachial symptoms were relieved by tenotomy of the scalenus anticus muscle. Garré believes that scoliosis is due to unequal development of cervical ribs.

SURGICAL CONSIDERATIONS

Surgical treatment should be considered: (1) if the patient complains of pronounced pain or of sensory or circulatory disturbance sufficient to incapacitate him; (2) if the patient presents evidence of atrophy in the arm or hand of the affected side, and (3) if there is evidence of circulatory disturbance on the affected side, especially if the pulse at the wrist can be obliterated or markedly reduced by extending the neck or rotating the head, even though the brachial symptoms are only slight.

Surgical treatment may be indicated and should be considered (1) in a group of anomalies in the supraclavicular triangle which gives rise to symptoms similar to those produced by a cervical rib, and (2) in cases of mild paræsthesia, but if there is an underlying neurotic tendency, operation should be advised cautiously and left to the patient's option.

Surgical treatment is not indicated if cervical ribs are found accidentally and the patient is free from specific symptoms. It is well to refrain from informing the patient of this finding, for fear of precipitating neurosis based on the consciousness of it. (Figs. 4, 5, 6, 7.)

SURGICAL TECHNIC

A cervical rib has generally been removed by the midcervical or post-brachial approach, an attempt being made to remove or resect the rib and to divide any bands which might be present after the cervical trunks and the brachial plexus had been displaced forward. This procedure involves considerable traction on the nerve trunks, which too frequently produces obstinate anæsthesia and palsy. Moreover, it has been difficult by means of the posterior approach to disarticulate complete cervical ribs because of the close proximity of the subclavian artery, which frequently rests on the cervico-thoracic articulation.

FIG. 4.—The incision employed.

For these reasons, we employed the anterior transbrachial approach to the cervical rib. The incision is somewhat similar to that used for the mid-cervical approach, except that it extends forward and mesially over the sternoclavicular articulation and thus permits mesial reflection of the clavicular attachment of the sterno-cleidomastoid. The fat and subareolar tissue in the supraclavicular triangle are reflected upward and laterally; the omohyoid muscle is divided laterally; the dissection is then carried upward into the lower border of the posterior triangle. We expose at this plane the carotid sheath mesially, the anterior surface of the scalenus anticus muscle with the phrenic nerve passing across the anterior surface of this muscle, the lateral portion of the subclavian artery (which takes a forward and lateral course from underneath the tendinous attachment of the scalenus anticus muscles) and the brachial plexus. The transverse cervical and suprascapular arteries are divided and ligated during the dissection. On observing the relation of the tendinous attachment of the scalenus anticus muscle, the subclavian artery, and the brachial plexus near the cervical rib, one is able to demonstrate how the scalenus anticus muscle compresses the subclavian artery from one-half to one-third its normal size; this pressure is transmitted posteriorly and laterally by the subclavian artery to the lower and middle trunks of the brachial plexus as they lie on the cervical rib. The degree of compression depends directly on the width of the scalenus anticus attachment and the angle of the cervical rib, which determines the width of the space between the lateral portion of the muscle and the rib. (Figs. 8 and 9.)

Prior to the removal of the cervical rib, tenotomy is performed on the

scalenus anticus tendon right at its attachment, permitting it to retract and to be elevated mesially for exposure of the subclavian artery in the supraclavicular triangle. The subclavian artery is then dissected free; this usually remains constricted, even though released. In the two cases of gangrene of the fingers, there were calcareous deposits in the wall of the subclavian artery at the point of constriction. Following tenotomy, the seventh and

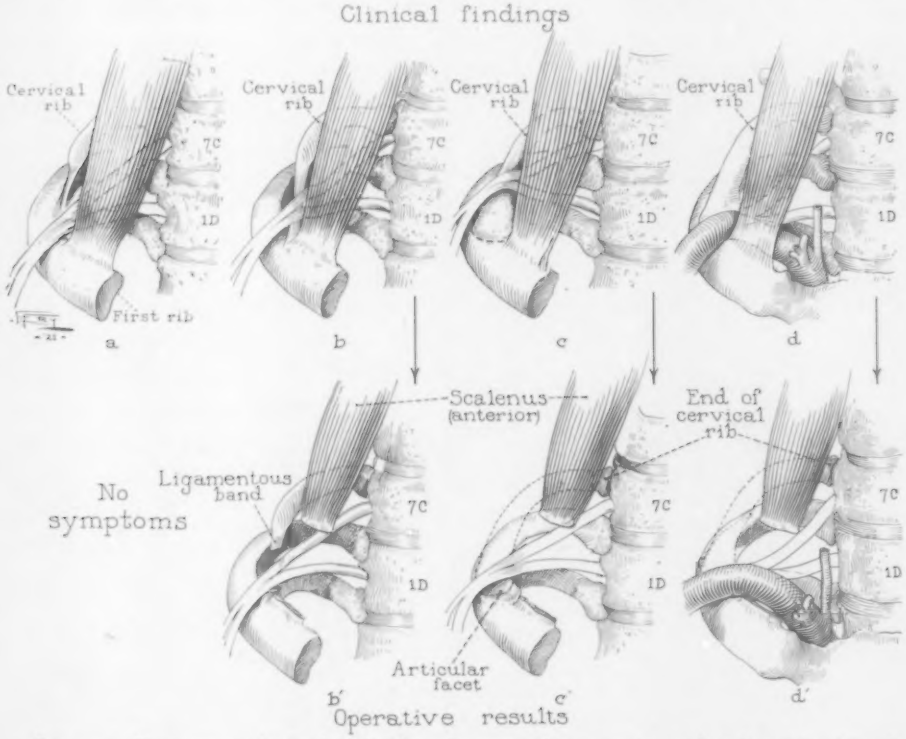

FIG. 5.—*a*, The presence of a cervical rib with a fibrous band between the cervical rib and the thoracic rib, without the production of symptoms, due to ample space between the lateral border of the scalenus anticus muscle and the ligamentous band of the cervical rib. *b*, Compression of the lower trunk of the brachial plexus by the scalenus anticus against the fibrous band. *b'*, Relief of compression by tenotomy of the scalenus anticus and division of the fibrous band. *c*, Compression ot the lower trunk of the brachial plexus by the scalenus anticus against the completely formed cervical rib. *c'* Relief of compression by either tenotomy of the muscle or resection of the rib. *d*, Compression of the lower trunk of the brachial plexus and the subclavian artery against the completely formed cervical rib. *d'*, Relief of compression by tenotomy of the scalenus muscle or by resection of the cervical rib.

eighth cervical and first dorsal roots are dissected free, care being taken not to injure the vertebral artery or the inferior thyroid, which lie along the mesial side of the field, anterior to the transverse process of the seventh cervical vertebra. The next step is to elevate the seventh cervical root upward and backward with a tape about the nerve, and to retract the inferior trunk downward. This permits excellent exposure of the spinal articulation of the cervical rib. The dissection of the rib is then carried laterally and downward between the seventh and eighth cervical roots for a distance of about 4 cm., when the inferior trunk is retracted with the middle trunk upward and backward, and the subclavian artery is retracted forward and mesially to expose the articulation of the cervical rib on the first thoracic.

The dissection with the disarticulation is then completed and the rib removed through the latter exposure.

In the transcervical or the postbrachial approach, the surgeon is usually content with elevating the brachial plexus and removing the rib, or as much of it as is possible, from behind, without exposing the scalenus anticus muscle, the subclavian artery, or other tissues in front. Because of the occasional post-operative palsy which ensued and the greater ease in operation, one of us (Adson) was persuaded to use, and subsequently to adopt, the anterior approach, in which the clavicular attachment of the sternocleidomastoid muscle is reflected to expose the scalenus anticus muscle, the subclavian artery, and the brachial plexus. One can readily observe the pressure produced by the scalenus anticus muscle when the neck is extended backward or the head is rotated toward the affected side.

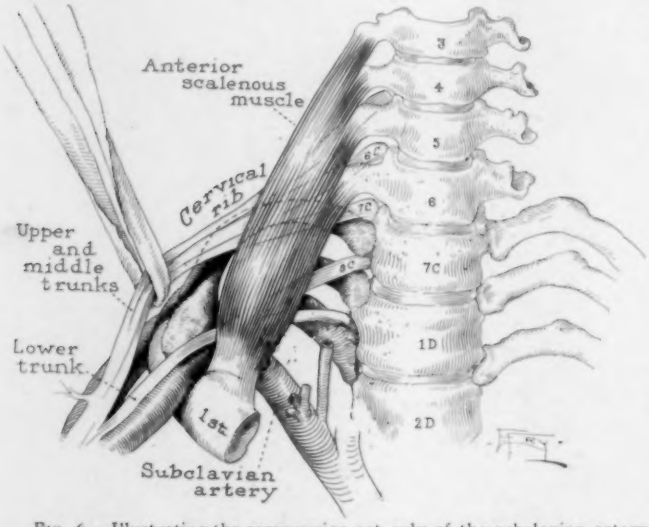

FIG. 6.—Illustrating the compression not only of the subclavian artery and the lower trunk, but irritation of the entire brachial plexus by the scalenus anticus against the completely formed cervical rib.

After having removed several ribs according to this technic, and having studied the mechanics which produce the symptoms, we were convinced that, with the exception of the one case previously referred to, removal of the cervical rib was really unnecessary, inasmuch as the subclavian artery and the brachial plexus were immediately relieved from pressure and irritation upon severance of the scalenus anticus muscle from its insertion. The latter procedure was much less difficult and more effective since the subclavian artery was then permitted to recede and take on its normal size, provided operative treatment was instituted before any permanent change had taken place. All traction on the brachial plexus is removed by the tenotomy of the scalenus anticus muscle.

The ulnar nerve rides over a bony prominence where it is constantly subjected to motion without symptoms being provoked; there should be no more likelihood of symptoms arising in the brachial plexus when it merely lies on the cervical rib, with little or no motion and no traction on it. Accordingly, we have operated on four patients by means of the anterior approach, dividing the tendinous attachment of the scalenus anticus muscle without removing the cervical rib; symptoms were completely relieved.

REVIEW OF CASES

In reviewing the histories of a series of 540,413 new patients registered at the Mayo Clinic between January 1, 1910, and October 1, 1926, we find 303 cases in which cervical rib was diagnosed. This represents an incidence of 0.056 per cent.

Of these patients, eighty-four were males, and 219 were females. Röntgen-ray examination revealed a cervical rib on the right in seventy, a

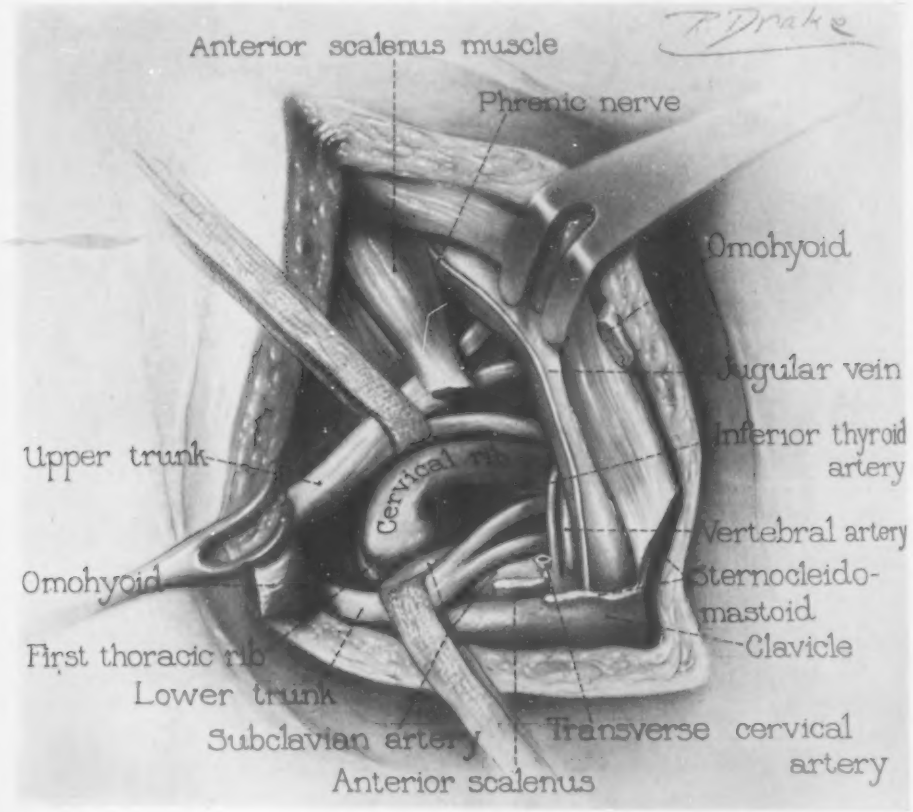

FIG. 7.—The anterior approach to the cervical rib when resection is advisable.

cervical rib on the left in ninety-one, and bilateral cervical ribs in 143. In cases of unilateral cervical rib, there frequently exists a supernumerary costal tubercle on the opposite side, which does not extend beyond the transverse process of the cervical vertebra and is, therefore, not classified as a cervical rib; it would fall, however, in the first group of Gruber's classification.

In 167 of this group (55 per cent.) the presence of cervical ribs was discovered accidentally, there being no symptoms. In 100, although the radiograms were positive, the symptoms were mild and of such a character that we deemed surgical treatment inadvisable; in seventy-seven of the 100 there was indefinite pain in the neck and shoulder, radiating only slightly down the arm and hand; in five the pain was localized and radiated along the ulnar

nerve; in two it radiated along the course of the internal cutaneous nerve; and in four it radiated definitely over the brachial plexus, but was not severe. In twelve cases the pain was exaggerated by rotating the head, or by elevating the chin. Slight atrophy was observed over the ulnar distribution in twelve. Subjective anæsthesia was present in the ulnar distribution in seven, in the internal cutaneous in two, and in the brachial distribution in four. Circulatory disturbance was present in four. The patients presenting slight atrophy and subjective anæsthesia will seek surgical interference, no doubt, sooner or later.

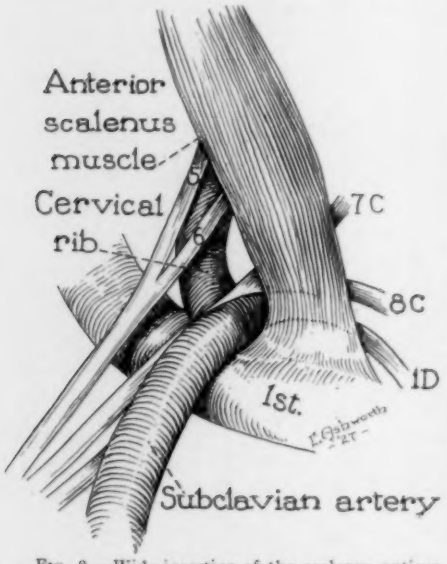

FIG. 8.—Wide insertion of the scalenus anticus with resultant compression of the subclavian artery and inferior and middle trunks of the brachial plexus.

SURGICAL CASES.—Surgical treatment was administered in thirty-six cases; there were eleven males, and twenty-five females. In fifteen cases symptoms were confined to the right side, in eighteen to the left side, and in three they were bilateral. Diffuse, darting, and aching pain was present over the brachial distribution in twenty-six; in twenty-two the pain radiated definitely over the ulnar distribution, and in nineteen over the internal cutaneous nerve. Subjective or objective sensory disturbance was present in the brachial distribution in nine, in the ulnar in eleven, and in the internal cutaneous in six. Atrophy was present in the ulnar distribution in eight, and circulatory phenomena, consisting of vasomotor changes, cyanosis, trophic disturbances of the finger tips, and impaired pulse volume on the affected side in thirteen. In two cases gangrene had affected the finger tips. The pain in the shoulder and the arm was occasionally relieved by elevating the shoulder on a pillow.

The transcervical approach, posterior to the brachial plexus, was used in twenty-three cases; the anterior approach, as described in the present technic, was used in thirteen. Complete relief from symptoms was afforded in twenty-six, and partial relief in four; failure of relief was reported in six. Of the six failures, the anterior approach was followed in one case. In this case, the rib was completely removed, and the persistence of symptoms was due probably to the fact that many of the indefinite pains of the neck and shoulder were not caused, primarily, by the presence of the cervical rib, especially since the nervous system was unstable and many other symptoms were complained of.

The post-operative course in eight of the cases in which operation followed the posterior approach was complicated by numbness, and in four by

slight palsy. In two of the cases in which the anterior approach was employed, the pleura was accidentally opened to the size of a pin point, but sufficiently to produce partial pneumothorax. While this accommodated itself in a few days, it was of sufficient moment to warn the surgeon of the possibility of injury to the pleura, when dividing the scalenus anticus muscle, as the pleura frequently extends into the supraclavicular triangle in cases of cervical rib.

In two of the cases of bilateral cervical rib, there were marked symptoms on the right side. Both of these patients were men, and both were laborers, one aged thirty-four and the other thirty-three. In both there was gangrene of the fingers; in one it had affected the third and fourth fingers, in the other the second and third fingers. The subclavian artery in both of these cases was found to be markedly compressed, remained kinked, and failed to dilate after division of the scalenus anticus muscle. Due to the changes in the wall of the artery, the vessel felt calcareous and pipestem-like. In both cases the anterior approach was followed.

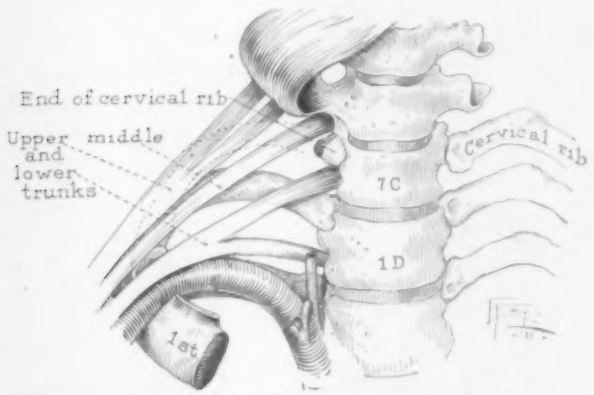

FIG. 9.—Illustrating the relief from compression of the lower and middle trunks of the brachial plexus, and the subclavian artery, with recession of the subclavian artery, following tenotomy of the insertion of the scalenus anticus.

In one of the cases the radial and ulnar pulse was perceptible, but was greatly reduced in volume. Prior to the patient's dismissal, following removal of the cervical rib, it was deemed advisable to amputate the tips of the two gangrenous fingers.

In the second case not only was the subclavian artery sclerosed, but the radial and ulnar pulses were obliterated. The immediate convalescence following division of the scalenus anticus muscle and resection of the cervical rib was uneventful. After primary union of the wound, the patient was dismissed from the hospital. The operation was performed June 30, 1925. July 9, after having been dismissed from the hospital, the patient suddenly experienced a severe pain in the neck, in the region of the wound, and we discovered an extensive hæmatoma developing underneath the skin. The wound was promptly opened, and the subclavian artery was found to be bleeding profusely. We controlled the bleeding by the use of a muscle slab over the opening in the subclavian artery and packs until July 15, when a second hemorrhage occurred. We then exposed and ligated the subclavian artery, but the patient succumbed later to the effects of the hemorrhage despite transfusion and other emergency measures.

CAUSE OF SYMPTOMS.—Todd believes that the symptoms are due to the

diminished obliquity of the thoracic operculum, the distance of the inner border of the first rib from the median line of the body assisted by the relative widening of the shoulder girdle, the growth of the clavicle, and the sinking of the shoulder girdle. His original statement in 1911,[40] "Arterial symptoms are caused by the action, directly by the scalenus and indirectly by the diaphragm, on an artery with a further and more tortuous course to pursue," was modified in 1912[41] when he asserted that the contracting scalenes muscles cannot compress the subclavian artery. He further stated: "The vascular symptoms occurring in cases of so-called cervical rib are not mechanical in origin, but are trophic in character and are caused by paralysis of the sympathetic fibres passing to the vessels. The same nerve which supplies the skin and muscles supplies the vessels, and hence trophic changes occur in the same area in either vessels or muscles or skin.[41]

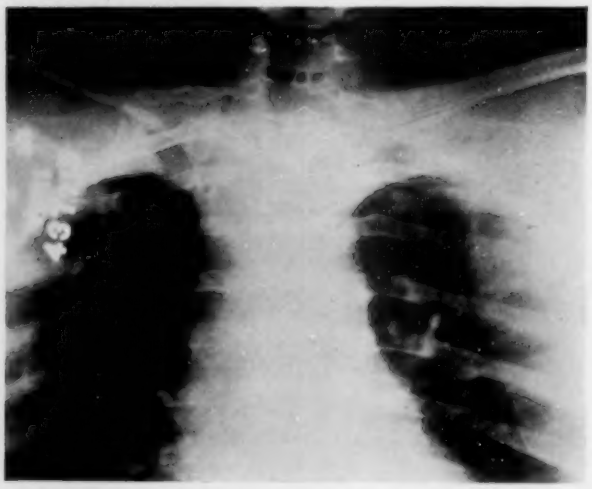

FIG. 10.—Completely formed right cervical rib presenting an articular joint in the middle, and an incompletely formed cervical rib on the left. In this case the symptoms were right-sided, and were associated with reflex cough.

It is difficult to explain on one hypothesis: (1) the compression of the artery (which is observable at operation and is not to be attributed to formalin fixation of the cadaver); (2) diminution of pulse volume in the vessels of the affected arm; (3) cyanosis of the skin of affected arm (in some cases); (4) variability of this pulse volume and cyanosis when scalene muscles are put on tension by suitable movements; (5) pathologic changes in subclavian artery where it crosses anomalous rib; (6) pathological changes in distal arteries and arterioles, and (7) gangrene of fingers.

Clinically, we were able to demonstrate the influence of the scalenus anticus muscle by having the patient elevate the chin and extend the neck or rotate the head to the affected side while taking a deep inspiration; this produces paræsthesia over the distribution of the brachial plexus and, frequently, obliteration of the pulse at the wrist on the affected side. This was well illustrated in the case of a railroad engineer, who complained of paræsthesia in the right arm, chiefly over the distribution of the ulnar and median nerves, in conjunction with cyanosis of the arm and hand. These symptoms were initiated when, at work, he was compelled to look backward through the cab window; if it was necessary for him to do so for any appreciable length of time, the right hand and arm became so numb and weak that he was unable to use them. The arm also became more cyanosed.

When it is considered that the subclavian vein is beyond the field of possible compression by the scalenus anticus, Todd's argument concerning the influence of disturbance of the sympathetic innervation seems essential to the explanation of the symptoms, especially the cyanosis. It is impossible to concur in his opinion, however, that this disturbance amounts to paralysis, in the face of the alterability of pulse volume and cyanosis by such clinical tests as we have described. If he is justified in attributing the pathologic changes in the distal vessels to disturbance of sympathetic innervation, and if the histologic picture which he has described can be observed with any constancy in cases of cervical rib, a clearer light will be thrown on the cause and nature of the thromboangiitis obliterans.

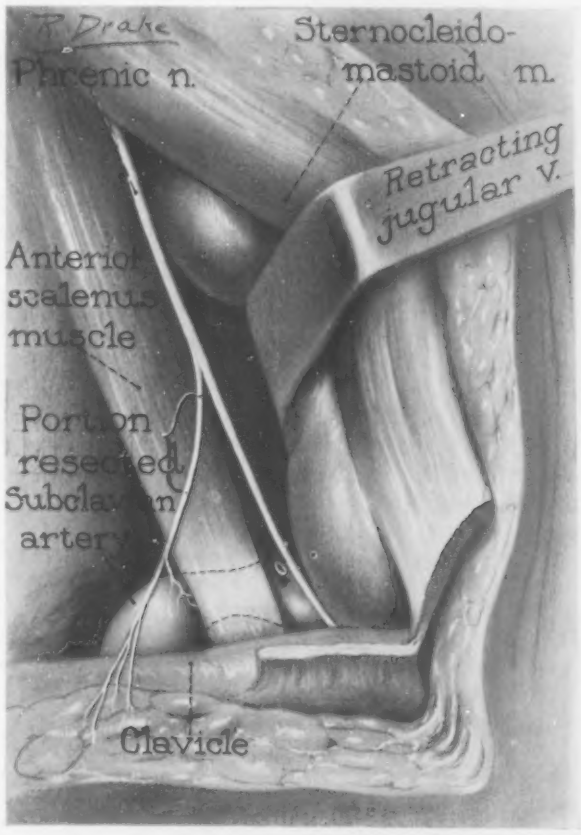

FIG. 11.—In this case brachial and vascular symptoms were relieved by tenotomy of the scalenus anticus muscle, and the reflex cough by resection of the anomalous sensory branch of the phrenic nerve.

However valid the hypothesis of disturbance of sympathetic innervation, we believe that insufficient emphasis has been placed on the influence of the scalenus anticus muscle which produces compression of the subclavian artery and of the brachial plexus against the cervical rib. During the height of muscular development the belly of the scalenus anticus muscle compresses the subclavian artery and the lower trunk of the brachial plexus to a greater degree than during childhood or the later periods of life; this we believe accounts for the symptoms during this period. It is true, also, that during this period of life the individual carries out the greatest physical efforts, placing a greater strain on the shoulder; this in turn causes the shoulder girdle to drop. This explains the greater frequency of right-sided symptoms in the presence of bilateral ribs, inasmuch as most people are right-handed and tend to lift the heavier weights with the right hand.

The infrequency of symptoms in the presence of cervical ribs is explained,

we believe, by an additional factor which we have observed in the exploration of cervical ribs with reference to the tendinous insertion of the scalenus anticus muscle. In cases associated with circulatory disturbance and brachial symptoms insertion is invariably wide, the muscle is reflected laterally beyond the operculum to and onto the cervical rib; this narrows the space between the lateral border of the scalenus anticus muscle and the cervical rib, and accounts for the pressure symptoms. In the absence of symptoms, the insertion is found more mesially in a narrower band, and a wider space is thus afforded between the lateral border of the scalenus anticus muscles and the cervical rib. It is obvious that if the rib takes a wide, lateral course before it turns forward and downward, the space between the rib and the scalenus anticus muscle is ample for the descent of the subclavian artery on the lower trunk of the brachial plexus without pressure. The observations which we have made have been facilitated perhaps by the anterior method of approach, which we have employed for exposure of the brachial plexus.

In view of our convictions concerning the influence of the scalenus anticus muscle in compressing the subclavian artery, and the inferior and middle trunks of the brachial plexus, we present the following case:

ILLUSTRATIVE CASE

The patient was a housewife, aged fifty-three, and the mother of four children. The medical history was negative except for the current complaint, which had begun one year before, of pain in the posterior cervical triangle, with radiation to the shoulder. For four weeks previous to admission, spontaneous, hacking, reflex cough had been occurring every few seconds.

The physical examination, the laboratory tests, and the neurologic investigation were negative except for symptoms referable to the complaint. A cervical rib could be palpated on the right. A bruit was present over the right subclavian artery. The pulse in the wrist was interrupted by extension of the neck in conjunction with inspiration; this also caused exaggeration of the pain and radiation into the arm. The röntgenogram revealed bilateral cervical rib. On the right the rib was completely formed and jointed; it was incompletely formed on the left (Fig. 10). The possibility of aneurism was ruled out by physical and radiologic examinations. Exploration of the right cervical rib was advised. The patient was informed in advance that probably two operations would be necessary, since we intended only to divide the scalenus anticus muscle at the first operation and to remove the rib at the second operation, if the symptoms persisted. During exploration of the scalenus anticus muscle through the anterior approach, it was observed that, although the phrenic nerve took its normal course, there was an additional branch which turned obliquely outward at a point 5 cm. above the costal attachment of the scalenus anticus muscle (Fig. 11), crossed the subclavian artery, and was adherent to it just lateral to the scalenus anticus muscle. This branch was slightly smaller than the usual size of the phrenic nerve and extended from a mass of adhesions over the subclavian artery in the subareolar tissue above the clavicle, apparently as one of the supraclavicular sensory nerve fibres; in all probability it was a continuation of the fourth or fifth cervical sensory fibres. The anomalous nerve was resected, the phrenic nerve being left undisturbed, and tenotomy of the scalenus anticus muscle at its insertion on the thoracic rib was performed. Following this, we dissected free the subclavian artery and the two lower trunks of the brachial plexus. The rib was prominent behind the brachial plexus, but immediately on division of the scalenus anticus muscle there was no further pressure either on the vessels or on the nerves, and the wound was

closed expectantly without removal of the cervical rib. The reflex cough was relieved completely and all pain in the neck, shoulder, and arm disappeared. The patient was dismissed after an uneventful convalescence, without removal of the cervical rib.

In view of the gratifying result obtained in this case, we have followed the same procedure in four cases since in which symptoms were referable to a cervical rib. The results have been as good following simple division of the scalenus anticus muscle as they were after removal of the cervical rib, and trauma to the brachial plexus was avoided. Therefore, we feel justified in advocating the anterior approach and division of the scalenus anticus muscle without removal of the cervical rib.

CONCLUSIONS

1. In about 55 per cent. of the cases reviewed in our series, the cervical ribs were symptomless.

2. Patients with cervical ribs without symptoms should not be informed of the accidental finding, as this may give rise to neurosis with symptoms referable to the rib.

3. The surgical indications depend directly on the degree and the type of the incapacity produced by the presence of pain, hyperæsthesia, anæsthesia, and circulatory disturbance. Surgical treatment should not be advised for mild, indefinite pain in the neck and shoulder.

4. The anterior approach and tenotomy of the scalenus anticus muscle are preferable to the transcervical approach and resection of the cervical rib, since the same relief is offered, the procedure is less formidable and post-operative numbness in the arm and palsy of the brachial plexus are avoided.

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BRACHIAL PLEXUS PRESSURE BY THE NORMAL FIRST RIB*

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Fairly familiar now is the phenomenon of pressure on the brachial plexus or, sometimes, on the subclavian artery, by a supernumerary (cervical) rib or by a band extending from the end of a rudimentary cervical rib. That the same pressure on the plexus may also be produced by an entirely normal first thoracic rib has been recognized by some of our colleagues in Great Britain and Australia. I have found in the literature of no other country, however, any reference to normal rib plexus pressure, except an article I wrote with the collaboration of Henry Milch.[3] In that communication we discussed first rib anomalies, the theories concerning their formation, and the mechanics of rib pressure on the plexus; we cited the few recorded cases of brachial nerve pressure by an *abnormal* first rib (two of which were operated on †); and we abstracted some reported cases of resection of a *normal* first rib for the cure of brachial pressure neuritis.‡

It is my purpose now to report some cases in which pain in the arm was relieved by carrying the shoulder in an elevated position (for the purpose of taking off the drag of the plexus over the rib); to describe a case in which I resected a normal first thoracic rib for presumed brachial plexus pressure; and to discuss the technic of that operation.

Edwin Bramwell,[1] the Edinburgh neurologist, was the first to suggest (1903) a pressure relationship between the first rib and the first dorsal nerve root, entering the plexus, as an explanation of symptoms such as we now recognize as occurring with cervical rib, and which Buzzard had described in some of the cases he reported under the title "uniradicular palsies of the brachial plexus."[4] And Thomas Murphy,[10] of Australia, appears to have been the first to resect a normal first dorsal rib for the relief of this condition. The symptoms disappeared promptly after the operation.

Three years later, Morley,[9] in England, reported the case of a woman of forty-two with wasting of the hand muscles and long-standing pain in the distribution of the lower cord of the plexus, which was aggravated by carrying weights and relieved by elevating

* Read before the New York Surgical Society, February 23, 1927.

† In the previous paper a case operated on by Thorburn is classed as one of thoracic rib pressure because so cited by other authors and because Thorburn said the bone resected "closely resembles an imperfect first dorsal rib." It was described by him as a cervical rib, however, and the röntgenogram showed it to be such. Morley's case we grouped, by error, with the abnormal instead of the normal rib cases.

‡ I have found no addition to the literature since the above article was published except the brief report by Henry and Handousa,[7] in Cairo, of a case of flaccid paralysis of the upper extremity appearing suddenly, with fever, and followed by the gradual development of gangrene of the second, third and fourth fingers, without sensory loss. When the palsied arm hung, subluxated at the shoulder, the radial pulse disappeared; when it was lifted the pulse returned. The reporters attributed the gangrene to compression of the subclavian artery at the thoracic inlet.

the arm in a sling or on the arm of a chair. Upon resecting a normal first rib the pains disappeared.

In 1920, Wheeler [11] resected a normal rib in a man of thirty-five for the relief of coldness and wasting of the hand, and weakness involving the median and radial as well as the ulnar nerves. He had only slightly altered sensation in the fourth and fifth fingers, no pain, except at the outset, and decided increase of the gripping power of the hand when it was raised over the head. The result of the operation is not stated.

In 1919, Stopford,[12] of Manchester, recorded that he had encountered within two years ten cases of brachial nerve pressure by a normal rib. Nine of these were operated on (by Telford, Hey, Douglas), and seven are reported in detail.

Bramwell and Dykes [3] reported in 1921 that Sir Harold Stiles had operated upon "several" cases of brachial pressure by a normal rib, with very satisfactory results. Only a few of these are detailed. Stiles himself has not published these cases, but he has described the technic of the operation.[11]

As some of these authors observed, the cases were of the type that often are, and several of them had been, dubbed "neuritis," "neuralgia," "progressive muscular atrophy," etc. A few of them were traumatic in origin, *i.e.*, the symptoms developed after an injury (*e.g.*, fracture of the clavicle) that caused sagging of the shoulder. In most cases the symptoms developed spontaneously, sometimes during adolescence; but they were often initiated or aggravated by exertion or dragging down on the arm by carrying heavy objects or wearing a heavy coat, and relieved by elevating the arm. In some patients the condition was worse in winter than in warm weather. No preponderance of either arm or either sex is to be gathered from the reports.

Sometimes the earliest symptom was pain along the ulnar border of the forearm. In most of the cases described in detail, the symptoms, as in most of the recorded cases of cervical rib, were chiefly in the distribution of the lower trunk of the brachial plexus (eighth cervical and first dorsal roots), viz., pain or sensory disturbances along the inner aspect of the arm and forearm and in the fourth and fifth fingers (medial brachial cutaneous, medial antibrachial cutaneous, and ulnar nerves) and atrophy of the hand muscles (probably chiefly ulnar nerve). In some cases there was also involvement of the median and radial nerve sensory areas. Common symptoms were coldness of the hand (sometimes associated with slight duskiness), weakness of the hand, and pain in the arm. Trophic sores are reported in two of Stopford's cases. Where the objective sensory disturbances are described, the loss of protopathic sensibility was greater than the epicritic loss. Stopford, who particularly called attention to this, had suggested that the dissociation is characteristic of nerve compression.

It is of interest, and importance, to note that in one of Stopford's cases and in one reported by Bramwell and Dyke, there was a cervical rib on the affected side (in one case on both sides), but at operation the pressure was found to be by the the normal first rib, which was accordingly resected, and not by the supernumerary rib, which was therefore not molested. In both instances there was immediate relief of symptoms.

It would appear that in the above cases of normal rib resection the procedure was promptly followed by relief or, more often, by disappearance of the

sensory and vascular (vasomotor) symptoms. In many the pain and, if present, the cyanosis of the hand vanished at once. Some of the cases, however, were reported within a few months after operation; and there is no published record of any late results. I have a letter from Professor Stopford, dated December 22, 1926, in which he gives the following report on the ten cases he published in 1919:

CASE 1.—I have never seen this patient again, as he was a soldier and was transferred to another command. Although he made an excellent recovery after the operation, I understand from the letter received three months after he left my charge, that he began to suffer from some pain again and also vascular or vasomotor symptoms. I believe this trouble persisted for at least a year, but the condition was never so bad as before the operation.

CASE 2.—This patient made a very good recovery and there was no relapse. About eighteen months after operation, the only difference in the two hands was some weakness on the affected side in cold weather.

CASE 3.—Made an almost complete recovery up to the time I last saw him, some six or eight months after operation. Indirectly I heard that he had a recurrence of some trophic disturbance, but I have no absolute confirmation, as the patient lived a considerable distance away and did not answer my letters.

CASE 4.—Perfect recovery with no recurrence of symptoms except some tenosynovitis recorded in the paper.

CASE 5.—Seen two years after operation and able to carry out her duties as a nurse.

CASE 6.—No further record.

CASE 7.—Perfect recovery and no recurrence some two or three years after. [This case was post-traumatic (gunshot fracture of the clavicle, with depression of the shoulder) treated by muscle education and faradism, not by operation.]

With regard to the three other patients treated in an earlier stage, as far as I have been able to ascertain the recovery has been complete and perfect and there has never been any complication since operation.

Thus of ten cases of brachial plexus pressure by a normal first rib (nine operated on), two are believed to have had some recurrence of symptoms, one could not be followed, and the other seven are cured.

AUTHOR'S CASES

1. Gertrude W., an apparently healthy married woman of fifty-two, was referred to me February 26, 1926, by Dr. F. P. Keyes, of Brooklyn, because of pain in the right arm, which she had had most of the time since 1917. This pain was chiefly in the outer aspect of the arm and sometimes radiated to the hand or the neck. *She volunteered the information that she liked to rest her elbow on the arm of a chair because it gave relief.* There was never any limitation of motion, but sometimes the pain was so severe that the patient could scarcely raise her arm. She had been treated for "neuritis" without benefit. No röntgenographic examination had been made.

Both upper extremities appeared quite normal. There was no atrophy, œdema, or discoloration, and there were no sensory, motor or reflex changes.

Above the inner end of the right clavicle the pulsation of the first portion of the subclavian artery was plainly visible. Applying the stethoscope to it very lightly there was heard a loud bruit, *which disappeared when the arm was raised.* Neither the pulsation nor the bruit were of the proportions that would suggest an aneurism, however; and no aneurism was seen in röntgenograms. On the left side the pulsation of the subclavian was not to be seen and the sound, by stethoscope, was of normal pitch and volume.

The radial pulses were equal, whether the arms were raised or dependent. The blood-pressure was 165/100 in both arms.

No mass was felt in the neck. There was no tenderness or apparent deformity or stiffness in the regions of the cervical and dorsal vertebræ. Applying the finger-tips lightly on each side of the neck, about where the plexus crosses the rib, elicited pronounced tenderness on the right side but none on the left; and somewhat greater pressure caused pain to shoot down the right arm, but not the left.

The heart, aorta and lungs, by physical and röntgenographic examination, were negative; the Wassermann reaction and the urine were also negative.

There was no drooping of either shoulder; and no history was elicited of any injury or illness that would account for the onset of the symptoms at the age of forty-five.

The X-ray films of neck, chest, shoulder were quite negative. In the absence of a cervical rib, pressure by a normal first dorsal rib was diagnosed. It was suggested that the patient consider the advisability of resection of the rib; and meanwhile she was instructed to carry her right shoulder raised, as much of the time as possible, by means of a snug ribbon sling passing under the flexed elbow, and to learn to keep the shoulder "hunched." This she did for several weeks and with so much relief that she was unwilling to submit to more definitive surgical treatment.

On November 22, 1926, she reported that from March to June the pain had been much less; in June it was again severe for several weeks, and again was relieved by wearing the ribbon sling; since then there had always been some, but never severe, pain—worse toward evening and soon after arising, but relieved by elevating the shoulder, with sling, chair arm or her own muscles. Examination on that date showed no change in the physical signs.

2. Howard S., a rather slender man of thirty-nine, was referred to me by Dr. Eli Moschcowitz, January 8, 1925. In 1921, he had had *right* subdeltoid bursitis, with subbursal lime deposit, which had caused pain and disability for several months but gave no symptoms after the summer of 1922. In September, 1924, he began to suffer with numbness and some pain in the fingers and arm on the *left* side. Röntgenograms then showed a small subbursal deposit on that side and, with the diagnosis of subdeltoid bursitis, he was treated by diathermy and baking with little relief. He said that in October, the tips of the fourth and fifth fingers were almost anæsthetic, that this improved and then had somewhat relapsed, and that he had a tingling sensation in the left hypothenar region. He complained also of moderate pain, chiefly along the inner aspect of the arm and forearm. All arm motions were free and painless.

Examination showed: Sloping shoulders and rather flabby muscles; no physical signs of subdeltoid bursitis; no loss of tactile or thermal sense in arm, forearm, hand or fingers; no atrophies; no disturbance of reflexes; no difference in the two radial pulses whether the arms were elevated or pendent; no mass in the neck, but pain in the arm when moderate pressure was made on the left brachial plexus. Röntgenograms showed no cervical or abnormal rib.

A ribbon sling, applied to keep the left shoulder elevated, gave great relief. On January 14th the patient reported himself distinctly better, and on the 21st still better. Exercises were then begun—hunching the shoulders, swinging Indian clubs, etc.,—to develop the trapezii. On February 25th the patient reported that he had very little disturbance. On April 20th he wrote that he had been free of all symptoms for several weeks, was delighted with the results of the treatment, and was continuing his exercises.

3. Arthur S., aged sixty-two, came to me July 22, 1926, because for three weeks he had had aching pain in the right side of the neck (about the third vertebral level), the upper right scapular region, the outer side of the right arm and along the inner border of the forearm and hand to the level of the fifth metacarpo-phalangeal joint. The pain disappeared: when in bed or otherwise recumbent; when the arm was raised (immediate

relief); when resting the elbow on the arm of a chair. It returned as soon as the arm hung by the side; and the patient had instinctively sought an arm-chair when he sat down. The arm felt weak, as when playing golf, but there was no limitation of or difficulty in any movement. No œdema or cyanosis of the hand had been noticed. There was no history of injury, recent infection or illness. The patient had been well and strong for many years. An osteopath had diagnosed his complaint as a lesion of the third cervical vertebra but had not succeeded in relieving it.

The patient was robust, well-built, 5 feet 10½ inches tall, of substantial and symmetrical musculature and apparently normal shoulder girdles. There was a tender area on the right side of the neck near the midline and on the level of the third cervical vertebra. Symmetrical pressure on each brachial plexus over the rib caused pain in the right arm, but none in the left; no cervical rib was palpable on either side. The right upper extremity was ¾ inch shorter than the left. Neither showed any atrophy, objective sensory disturbance, motor weakness, or alteration of reflexes. The radial pulses were full and equal in all positions of the arm. The pulsation of the subclavian artery was heard much more distinctly, with the stethoscope, on the right side than on the left—but that, I think, is of little significance. The urine was negative. The blood examination yielded in mgms. per 100 c.c.; non-protein nitrogen, 45; urea nitrogen, 24.3; uric acid, 4.3; creatinine, 1.7; sugar, 137; negative Wassermann reaction.

Röntgenograms showed a rudimentary cervical rib on the unaffected (*left* side), and what was interpreted as an anomalous condition of the articulation on both sides of the sixth and seventh cervical vertebræ.

A ribbon sling was applied to keep the shoulder elevated. In the course of three weeks the pain subsided very much. When the sling was worn the arm was quite comfortable. The pain in the neck continued but that in the upper scapular region had ceased. Golf did not aggravate the condition. By September there were only occasional slight pains, which disappeared if the arm was raised. In December, the patient reported that he had only slight pain occasionally in the neck and shoulder, none in the arm or wrist.

4. Mrs. W., aged forty-five, a tall, vigorous and athletic woman, an ardent pianist, wife of a New York surgeon, was referred to me February 23, 1927, by Dr. Morris Manges, of New York, because of pain in the right upper extremity. Twelve years ago, during her second pregnancy, she vomited a great deal and lost much weight. Two months before term she developed, rather acutely, pain in the inner aspect of the right forearm and the fourth finger, extending from elbow to finger-tip. This pain was severe and continuous until soon after childbirth. Two months thereafter she developed pain in the right shoulder, chiefly in the scapular region, and sometimes in the outer aspect of the arm. This lasted all that summer, then disappeared; and the patient was entirely well for about three years. Then, again during the period of an entire summer, she had numbness in the right hand and fingers on awakening, which often passed off on rubbing, but sometimes returned during the day as tingling and burning. There were then no pains. Since then, at irregular intervals, she has had pain in the right scapular region and burning pain along the inner aspect of the right forearm and fourth and fifth fingers.

Early in the autumn of 1926, while playing piano rather strenuously, she frequently noticed slight swelling of the fingers of the right hand lasting for several minutes. There has never been cyanosis or sweating of the hand. For the past two weeks she has had burning and tingling along the inner aspect of the right forearm and the fourth and fifth fingers and sometimes the hand has felt cold. For these two weeks or more also, she has had pain in the right shoulder, as before.

The patient has no pain during the night and, indeed, appears to be relieved by recumbency. She has also noticed that the tingling and burning disappear when the arm is raised, and that the grip in her right hand is much stronger when the arm is lifted above the head than when it is dependent. For many years she has noticed that

carrying any weights in the right hand causes a sensation of weakness in that arm and she avoids doing so. Wearing a fur coat causes this sensation of weakness in the right shoulder. She has noticed, too, that when her arm hangs she gets numbness in the forearm and in the fourth and fifth fingers. Active piano and tennis playing aggravate and sometimes appear to initiate her symptoms. She has never noticed any atrophies or loss of sensation. She has had no limitation of movement in her shoulder or pain on motion.

She was left-handed as a child but learned to write with her right hand. She cuts with her left hand. She has had no injury to her shoulder but had a fracture of her right arm and forearm in childhood, and a traumatic synovitis of her right elbow nine months ago. She says that her symptoms are aggravated when she eats sweets and

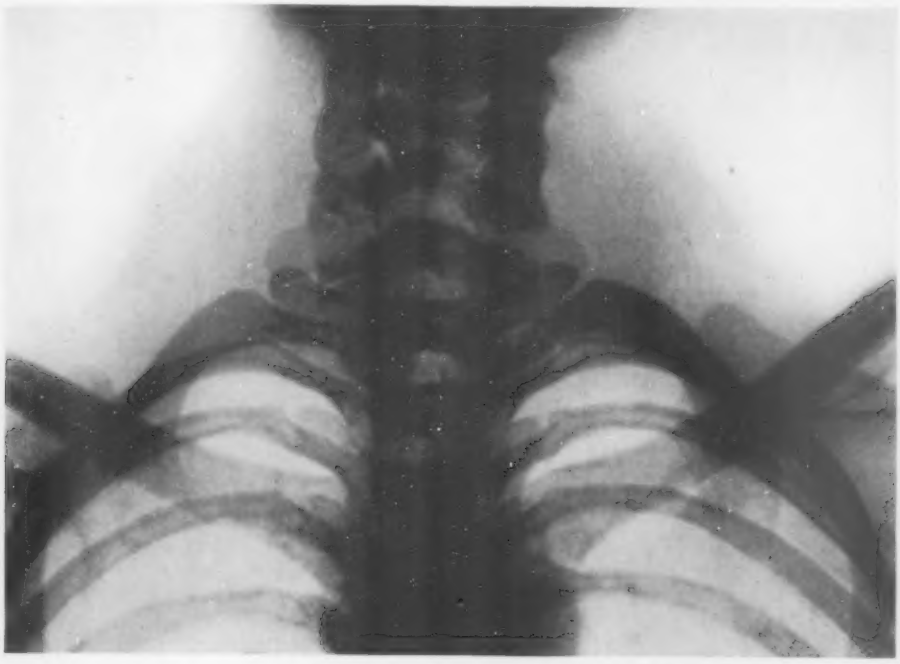

FIG. 1.—Mrs. M. C. Röntgenogram showing upper ribs.

pastries, but she has no hyperglycæmia or glycosuria. She has known that her right arm is a little longer than her left.

Aside from the fact that the right upper extremity is three-quarters of an inch longer than the left and that the patient has a double mitral murmur, physical examination of the chest, neck and upper extremities is in all respects negative. Röntgenograms of the upper thorax, neck and shoulders are also negative.

Her symptoms are typically those of pressure irritation of the lower cord of the brachial plexus.

5. Mrs. M. C., aged twenty-two, born in the United States, a teacher of acrobatic dancing, was referred to me April 21, 1926, by Dr. F. S. Mason, of New York, because of very severe pain in the entire right upper extremity, coldness, slight duskiness and sweating of that hand, and slight œdema of the extremity, felt and seen most in the fingers.

The condition had its beginning, rather abruptly, at the age of fifteen, and continued unabated and with great suffering for two years. The pain during that period was

severe, and the extremity was sensitive to the touch—so much so that for several nights the patient let the arm hang rather than bear contact with the bed. During these two years also the hand was swollen much of the time and often cold and blue. In the second year, for several weeks, she could not raise the arm, she said, nor feel pin-pricks nor distinguish hot and cold. She was seen by several physicians in Providence, R. I., but none, she said, had made a diagnosis (except neuritis) and no treatment gave any relief.

At the age of seventeen the symptoms disappeared spontaneously. In a few months they recurred, and had continued with varying severity and for periods of varying

FIG. 2.—Mrs. M. C. Photographs six days after resecting the first thoracic rib showing the incision used and its concealment by a necklace. The photograph on the left appears to show slight drooping of the eyelid on the left (unaffected) side. There was, however, no ptosis or Horner's syndrome on either side.

length. The free period was usually not long, but once had been about six months. At the time that the patient came to me she had been suffering for several weeks.

Her previous history suggested no illness or injury as a cause of this distressing condition, aside from which she enjoyed good health and good spirits; and there were no symptoms (or physical signs) suggesting disturbance of any of the viscera, including the ductless glands. The patient had five sisters and three brothers, none of whom had had any similar condition or any nervous affection; nor had her parents or their parents, brothers or sisters, as far as she knew. The left upper extremity was never affected. The pain in the right was sometimes present without any œdema, but there was never œdema without the pain. The latter might be at any part of the extremity but its maximum was in the fourth finger. Raising the arm gave only very transitory relief.

The patient was in apparent good health. Her general examination, and that of the urine and the blood, including the Wassermann reaction, were negative. There was nothing in her appearance, behavior or physical signs to suggest hysteria, even remotely.

The right hand was sufficiently œdematous to obliterate the normal cutaneous folds and to prevent the patient from fully extending or fully flexing the fingers. Œdema in the forearm and arm, scarcely noticeable on inspection, was manifest on picking up the skin. The hand was cold, sweating and slightly cyanotic, whereas the left hand was

warm, dry and of normal color and skin texture. The entire upper extremity was very hyperæsthetic, especially the hand. There was no atrophy or muscle weakness, or material change in the tendon reflexes. Aside from the hyperæsthesia there was no sensory alteration, protopathic or epicritic. There was no limitation in any movements of the extremity other than that in the fingers due to the swelling.

The neck and shoulders were normal on inspection. No cervical rib or other mass was palpable. Gentle pressure with finger-tips or stethoscope where the right brachial plexus crossed the rib caused pain to radiate down the arm and into the upper thoracic region. Pressure on the left side caused no pain radiation. In certain positions of the head a bruit or high-pitched singing noise could be heard when the stethoscope was

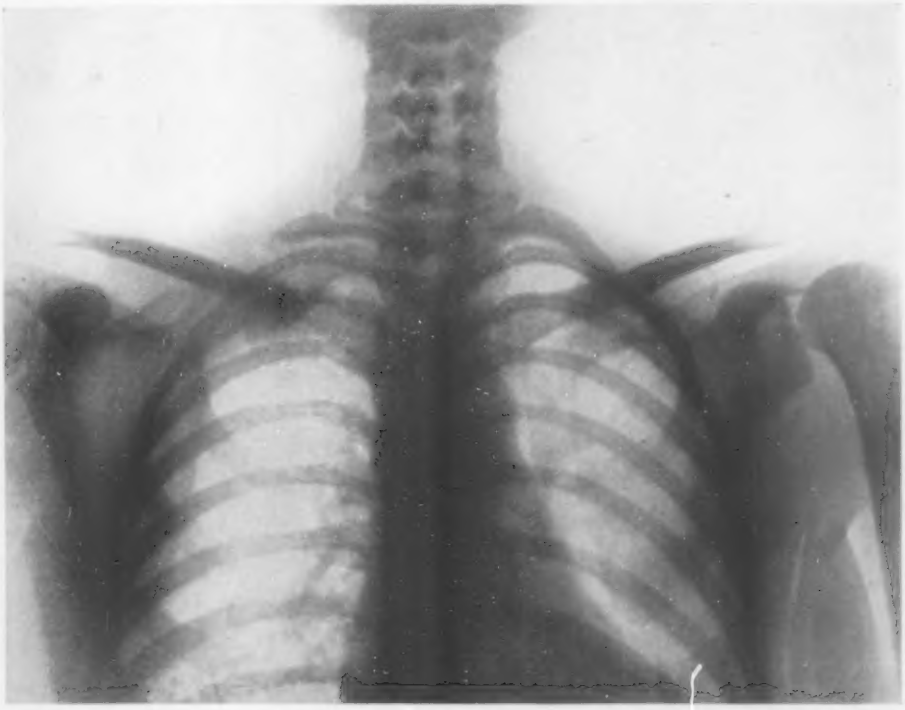

FIG. 3.—Mrs. M. C. Röntgenogram six days after operation to show the amount of rib resected.

pressed down over the first portion of the right subclavian artery, but not over the left; that, however, is a normal phenomenon, I believe.

The radial pulses were full, equal and unaffected by raising the arms. The blood-pressure was the same in both arms. Circumferential measurements showed only the slight difference that would be accounted for by the œdema. The right upper extremity is, however, one inch longer than the left, measuring from spine to finger-tip—a lengthening proportionately distributed through arm, forearm and hand. The patient and her dressmakers had also noticed this difference. The lower extremities are of equal length; they have never exhibited any disturbance.

Röntgenograms of the neck, right shoulder and upper chest showed no rib or other abnormality (Fig. 1).

This patient did not exhibit the characteristic symptoms of compression of the lower trunk of the brachial plexus—weakness and atrophy of the hand, anæsthesia or hyperæsthesia in the fourth and fifth fingers, pain and other sensory disturbances along the inner border of the forearm. Nevertheless, weighing all the data in her case and

considering the symptoms in some of the reported cases of rib compression (to which I shall revert), it seemed to me that hers, which appeared to be chiefly vasomotor, might well be caused by a cervical rib and, since she had no such supernumerary rib, might be due to pressure by her obviously normal first rib. Accordingly I advised its resection, to which the patient readily consented.

At the time of the *operation*, which was done under ether narcosis April 30, 1926, at the Hospital for Joint Diseases, the patient still had great pain in her arm and the hand was quite œdematous, cold, sweating and slightly dusky. Lying somewhat on her left side and with the head turned to the left, a simple curved collar incision about 11 to 12 cm. long was made on the base of the neck, sweeping from near the right sterno-

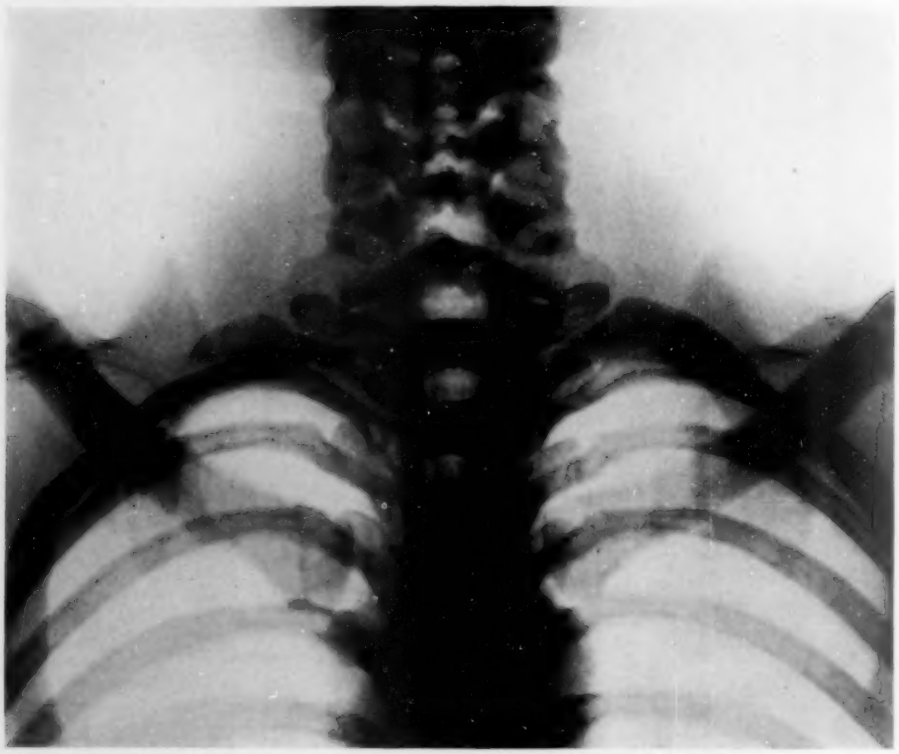

FIG. 4.—Mrs. M. C. Röntgenogram eight months after operation. The rib is not regenerated.

mastoideus insertion backward and outward to the trapezius, so planned that it would cross the plexus yet lie not too far out to be concealed by a necklace (Fig. 2). Retracting the cut edges of the skin, the platysma and the middle branch of the supraclavicular nerve were divided. The external jugular vein was divided, between ligatures, near its termination. The posterior belly of the omo-hyoideus, separated from its fascial attachment, was drawn downward and forward with the sternomastoideus. The layer of fat next exposed and lying immediately upon the emerging brachial plexus, was dissected up as a single sheet. The transversa scapulæ vessels were resected between ligatures as they crossed the plexus. The transversa colli vessels, which in this patient ran through the plexus, were likewise divided on each side of it. The scalenus anticus was identified, with the phrenic nerve crossing it and passing down between the subclavian artery and vein. The broad attachment to the first rib of the scalenus medius behind the plexus was identified, with the roots of the long thoracic nerve in and upon the hinder portion of the muscle.

The second and third portions of the subclavian artery ran downward in a straight line at an angle of about 65° with the clavicle from a point that appeared to be rather high in the neck. The vessel showed no constriction or dilatation. A thin prolongation of fascia running down along the artery was dissected off. The subclavian vein, lying behind the clavicle, appeared to present no abnormal feature. The attachments of the two scaleni to the first rib were readily exposed by retracting the plexus and the subclavian artery alternately backward and forward. No actual pressure on the medial cord of the plexus was demonstrated.

Intermitting the retraction on the plexus at short intervals, the scalenus medius was divided close to its insertion in the rib, cutting through all but a posterior portion, which was left uncut to avoid both undue retraction of the muscle into the neck and damage to the posterior thoracic nerve. Hugging the first rib close with a sharply curved elevator, it was separated from Sibson's fascia beneath. Nibbling through with a rongeur the rib was divided posteriorly about 2 cm. from the tip of the transverse process of the vertebra. The anterior portion of the rib was found to drop at once nearly a centimetre. Again with rongeur, it was divided in front at the scalene tubercle. Thus there was removed from beneath the plexus and artery a segment of the first rib 4 to 5 cm. in its outer circumference. The cut edges of the rib were smoothed with the rongeur. The uninjured pleura was exposed at the bottom of the wound with what I took to be the first dorsal root and the first intercostal nerve lying upon it.

In order to relieve any possible pressure on the vessels by the scalenus anticus, this muscle was divided from without inward through three-quarters of its thickness and about 1.5 cm. above the rib, leaving an undivided internal portion to prevent undue retraction of the muscle mass. In doing this care was taken that the phrenic nerve was not injured and that the posterior fibrous portion of the muscle, lying against the subclavian artery, was divided. The cut surface of the scalenus medius was brought down and sutured to the undivided portion of that muscle, which considerably lessened the large size of the dead space. Although the operation was practically bloodless throughout and there was exceedingly little oozing in the depth, a small rubber dam drain was inserted to the pleura. The fat was sutured back in place over the plexus. The platysma was reunited with chromicized catgut. The skin wound was closed with a subcuticular suture. A compressive gauze dressing was held with adhesive plaster straps. The patient's condition at the end of the operation was excellent.

The next morning the torturing pain and the œdema had already completely vanished, and the extremity was no longer sensitive to the touch. Quite cold and clammy before the operation, the hand was warm and dry and the patient could flex and extend her fingers fully for the first time in many weeks. There was some numbness in the thumb and index finger, and pain in the deltoid region, both due to traction on the plexus. They lasted several days.

The drain was removed in forty-eight hours; there was no discharge whatever. On the third day the patient was out of bed. On the sixth day, after removal of the subcuticular suture, she walked to the photographic and X-ray departments of the hospital —where the pictures showing, respectively, the line of the incision and the amount of rib removed (Fig. 3) were then made. On the eighth day she left the hospital, apparently cured, and with no disabilities from her operation other than anæsthesia in the distribution of the middle supraclavicular nerve and a scar on the neck that can be concealed by an appropriate necklace.

For several months she was free from all symptoms. Then, in October, when she resumed her dancing lessons—which included "cartwheels" and manual stretching of her pupils' thighs—there was a gradual return of the old pains and, soon thereafter, of the œdema, coldness and sweating of the hand. Added to these there developed a good deal of pain in the neck, extending sometimes behind the ear, sometimes into the

posterior aspect of the shoulder. A röntgenogram in December, 1926, showed no regeneration of the divided rib (Fig. 4). Now she is free from symptoms two months.

Stopford has written to me: "I have seen from time to time recurrences of trouble after the operation. The pain which recurs, in my experience, differs from that seen before operation, and I have often wondered whether the cause might not be one or more of the following: (*a*) insufficient amount of rib removed; (*b*) compression by callus or adhesion; (*c*) intraneural fibrosis, which I believe is quite common if rib compression has persisted for some time before operation.

"In some cases where there has been profound wasting of the small muscles of the hand, I have seen the pain relieved and the objective sensory disturbance reduced or removed by operation, but there has been little or no improvement in the muscles. This has led me to think that when atrophy of the small muscles has persisted for a considerable time or is very profound, prognosis as regards muscular power is bad. Whether this is due to intraneural changes or to a profound atrophy of the small muscles, I am not prepared to say."

It is, of course, possible that in my case the relapse of symptoms was due to too early return to manual activity. It is also possible, however, that the condition is an obscure vasomotor disturbance (concerning which no neurologist whom I have consulted has enlightened me); that it was not due to rib pressure; and that the dramatic disappearance of symptoms after the operation was a remission initiated in some way by manipulation of the plexus or the artery.

I have seen a quite similar case at the Hospital for Joint Diseases:

6. This was in a school girl of sixteen, born in Russia. For two weeks, beginning abruptly and without known cause, she had had severe pain in the right arm extending from neck to fingers, œdema of the forearm and hand, and some cyanosis of the hand. Full extension of the fingers was prevented by the œdema; both active and passive abduction of the arm were inhibited by the severe pain. There was exquisite tenderness in the neck on slight pressure over the right brachial plexus, which also caused pain to shoot down the arm. No bruit or abnormal pulsation was noted in the neck. The right deltoid region was exquisitely hypersensitive. There were no atrophies and no objective sensory disturbances. The brachial nerves were very tender in the arm. The pulses were equal. The extremities were of equal length. There was no droop of either shoulder. Röntgenograms were negative. The symptoms subsided in a few weeks. I have not been able to learn whether there has been any return.

In the absence of localizing sensory and motor medial cord compression symptoms in my operated case, the presumption of rib pressure seemed to me nevertheless justified by various considerations. Not all the reported cases of rib pressure relieved by operation had this lower trunk syndrome, and some of the cases had symptoms quite similar to mine. Thus, in Murphy's case (resection of a normal first rib) the symptoms had existed for eight years. There were "pain, numbness, coldness, tenderness and loss of power in the left shoulder, forearm and hand, with swelling and dusky blue discoloration

of wrist and hand . . . worse after any exertion . . . such as tennis playing or typewriting . . . severe in winter months and comparatively mild in summer. . . . The arm, forearm and hand tender and painful on pressure throughout their whole extent. There was no localization to any particular nerve. The hand and forearm were cold. . . . The patient could not close her hand. There was some impairment of sensation in the hand and some wasting of the forearm." On pressure over the plexus there was felt a tender point of resistance and pain shot down the arm.

In Hvoslef's [8] case (abnormal first rib in a male) there was steady pain in the left elbow radiating to the hand, which at times became cold and pale, and tingling in the fingers. No root distribution appears to have been made out.

In Hauswirth's [6] case, in which a fibrous band was found extending from the end of a cervical rib to the first rib, the patient, a girl of seventeen, had pain in the left shoulder, arm and forearm from pressure of any kind above the clavicle, pain on manipulation of the shoulder and, later, swelling, cyanosis and coldness of the hand and forearm and stiffness of the fingers.

All three of the above cases were promptly rid of their symptoms after resection of the rib; but, also, all three were reported within a few months of the operation.

Buzzard [5] said: "Results of . . . observations . . . had convinced him that pain of almost any description and any distribution within the upper extremity could be associated with the presence of cervical ribs." He doubted whether there was anything about the sensory symptoms which were quite characteristic and he referred to two cases of cervical rib in which vasomotor symptoms were the prominent features. One of them had been operated on, with excellent results.

Bramwell and Dykes, discussing pressure by the first thoracic rib, mentioned that coldness of the hand is very common. "No objective sensory disturbance may be detected, although very usually some sensory loss, which corresponds more or less to root distribution, is met with, tactile sensibility being less affected than painful and thermal sensibility." They describe five types of rib pressure, symptomatically. One of these is of "rare cases in which vasomotor disturbance is the striking morbid manifestation." The vasomotor symptoms, according to Todd,[13] are probably due to pressure on the sympathetic fibres in the first dorsal root.¶

THE TECHNIC OF RESECTION OF THE FIRST RIB FOR BRACHIAL PLEXUS PRESSURE

The steps of the operation are related in my case report. There are, however, certain details that need discussion.

The Incision.—Stiles, Telford,[12] and Wheeler, who described their proce-

¶ Pupillary signs are not to be expected since these sympathetic fibres are given off before the nerves reach the rib. In the few recorded cases of cervical rib with pupillary changes the supernumerary rib is presumed to have been only incidental to a syringomyelia.

dures, approached the rib by raising a triangular skin flap, fashioned by a transverse incision parallel to the clavicle and a longitudinal incision along the edge of the trapezius (Stiles, Wheeler), along the posterior border of the sternomastoideus (Telford). Such an incision would leave a scar disfiguring on a woman, but I do not doubt that it is necessary in dealing with a fat or muscular neck. For other subjects, however, I found on the cadaver and in my reported case that the incision here described and illustrated gives an adequate exposure. The first rib can also be reached from behind, as one does in thoracotomy for tuberculosis, by a longitudinal incision through the trapezius. This also would leave a scar that a woman cannot well cover, it would cause more or less drop-shoulder by division of the trapezius and, most important, it would not give a free exposure of the plexus and the subclavian artery, which one would want to inspect.

Hæmostasis.—The external jugular vein, the transversa scapulæ and the transversa colli are the only vessels beneath the platysma that require ligation; and if care is taken in separating and cutting the rib there should be little or no bleeding in the depth.

Retraction of the plexus should be as gentle as possible and should be intermitted very frequently.

The Periosteum.—A right-angled curved elevator is convenient for freeing the rib from its deep muscle attachments. Wheeler frankly states that he removed the rib subperiosteally. Stiles' and Telford's descriptions are not very clear on this point. In my case I tried to remove the inferior leaf of the periosteum with the rib. Unfortunately, the specimen was lost before I could examine it, so I am not sure that I did this. Theoretically, at least, it is better to remove the periosteum with the rib, lest the lower cord of the plexus, now lying on this periosteum, should become compromised by regenerating bone. Actually, however, this is probably not likely to happen. Subperiosteal resection is technically easier and it avoids the chance of injuring the first intercostal artery and the pleura. The pleura is, however, fairly well protected by Sibson's fascia, and even if it is torn a little, Stiles says that no harm results.

Dividing the rib is done with bone forceps by Telford, with bone forceps anteriorly and with Shoemaker's rib shears posteriorly, by Stiles. The first rib is rather broad and lies flat over the apex of the lung. I found, therefore, both on the cadaver and in my patient, that costotomes and bone-cutting forceps are awkward. The rib is easily divided, however, by biting through with a narrow-beaked angular rongeur. This has only the inconsequential disadvantage that it somewhat reduces the size of the bone resected, as a specimen.

The Scaleni.—Stiles cuts only the scalenus medius. Telford partially cuts also the scalenus anticus to increase the exposure of the rib; I cut it to relieve any possible pressure on the subclavian artery. The cut muscle retracts very much, greatly increasing the dead space created by removal of the rib.

Telford does not seem to make any effort to close this space. Stiles reduces it by suturing the retracted scalenus medius to the uppermost digitation of the serratus magnus. I found myself unable to do this both on the cadaver and on my living subject. I materially reduced the space, however, by drawing down the retracted portion of the muscle and stitching it to the undivided portion. In dividing the scaleni one must avoid the phrenic nerve on the anticus, and the long thoracic nerve on the medius.

Drainage.—In spite of the depth and the size of the dead space, if the wound is dry a drain is unnecessary. Neither Stiles nor Telford employs it; they depend upon the gauze dressing to obliterate the space.

SUMMARY

There are cases of pain in the arm, with paræsthesias and other phenomena, that are relieved by elevating the shoulder and by exercising the trapezius to keep it elevated. These cases, of which three are reported, are probably due to dragging of the brachial plexus over the first rib.

There are more severe cases in which all the phenomena of pressure by a cervical rib are produced by the pressure of an abnormal or even a normal first thoracic rib. Several have been cured by resection of the first rib. The technic of the operation is described.

When operating upon a case of cervical rib, it is important to observe whether the pressure to be relieved is due to this supernumerary, or to the normal first, rib.

Two cases are reported of intermittent severe pain and œdema in one upper extremity, occurring in adolescent females and perhaps due to plexus pressure by the first rib.

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PRIMARY ULCER OF THE JEJUNUM*

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That primary ulcer of the jejunum is a rare lesion is evident from the fact that up to 1921 none had been observed at the Mayo Clinic. A patient suffering from such a lesion came under our care in September, 1925.

The patient, S. K. (History Nos. N. S. 6606-7218), was first admitted to the University Hospital in August, 1925, with a chief complaint of pain in the epigastrium, belching, vomiting and loss of weight.

He had been troubled for six months with constipation and dull upper abdominal pain, with gaseous eructations and vomiting. The pain would occur about two hours after eating, was in the epigastrium and right upper quadrant and radiated across the upper abdomen to the left, occasionally to the back, but never downward. The taking of food did not relieve him, in fact it made him so much worse that he reduced his diet to such an extent as to cause a loss of thirty-seven pounds in weight. Sodium bicarbonate gave some temporary relief, but this was usually due to the vomiting which it induced. He had never had any hæmatemesis or jaundice.

His past medical history was negative.

The physical examination was negative except for slight tenderness in the right lower abdomen. There was no abdominal rigidity, no distention and no masses were palpable.

The tentative diagnosis was duodenal ulcer.

The laboratory findings were as follows: Blood count: Red blood-cells, 5,000,000; hæmoglobin, 100 per cent.; white blood-cells, 9700; polymorphonuclears, 62 per cent.; lymphocytes, 30 per cent.; large mononuclears, 5 per cent.; transitionals, 3 per cent. Urine: Negative. Wassermann: Negative. Gastric analysis:

	Free	Total
F.C.	12	34
1.	34	52
2.	42	66
3.	36	64
4.	52	94
5.	56	88
6.	48	66
Res.	16	38

X-ray (G. I.): Stomach negative. Duodenum uncertain. Colon: Ptosis of right side, considerable stasis. No tenderness over a visualized appendix.

Operation, September 3, 1925: Appendectomy. Operator, Dr. G. P. Müller. Right rectus incision. The stomach and duodenum and gall-bladder were carefully examined for evidences of disease, but none were found. The duodenum was in a somewhat high position, but was otherwise negative. The appendix was felt bound down in the right iliac fossa. The upper abdominal wound was closed.

A McBurney incision was then made and a chronically diseased appendix was removed through this incision. There were numerous peri-appendiceal adhesions.

* Read before the Philadelphia Academy of Surgery, February 7, 1927.

After operation the patient vomited daily. The vomitus was bile-stained. He was discharged from the hospital on September 19, 1925, with instructions to report back to the follow-up clinic in one month.

He did not return until November 15, 1925. Since discharge he had become progressively worse. The X-ray examination at this time showed a high jejunal obstruction. The abdomen was scaphoid, the peristalsis was about normal and no masses were palpable. There was some tenderness in the mid-abdomen.

The plasma CO_2 was 100 volumes per cent., but after giving him ammonium chloride by bowel, this was reduced to 78 volume per cent. He was given enteroclysis of tap water and saline hypodermoclysis for twenty-four hours before operation, which was performed by Doctor Müller on December 1, 1925.

Operation.—Resection of jejunum, gastro-enterostomy—posterior method. Dr. G. P. Müller. Left rectus incision. When the peritoneal cavity was opened, a small contracted bowel presented itself. This was followed upward toward the jejunum. About twelve inches from the duodenojejunal flexure a loop of dilated small bowel was encountered. On bringing this up into the wound the site of obstruction was easily seen. This consisted of an annular, sclerosing mass encircling the jejunum, while in the surrounding mesentery were numerous large lymph-nodes.

It was felt that the mass was either a sarcoma or a carcinoma. Resection appeared imperative so that this was done and the bowel brought together by end-to-end anastomosis. A posterior gastro-enterostomy was then done, the loop used being distal to the anastomosis.

The patient stood the operation quite well and was returned to the ward in good condition.

For two days his convalescence was uneventful, but on the evening of December 3, he began to vomit. A Jutte tube was introduced into the stomach for drainage. The abdomen became soft, the gastric distention was relieved and the patient improved considerably for twenty-four hours. The following day we gave him glucose and insulin intravenously. On December 7 his condition became worse, he began to vomit large amounts of bile-stained fluid, the pulse rose rapidly and his appearance was that of a high intestinal obstruction.

Under gas-local anæsthesia I opened the abdomen with a high left rectus incision. The stomach was opened along the greater curvature and the gastro-enterostomy opening was found. There was a great deal of bile-stained fluid in the stomach which was aspirated.

One rubber tube was placed in the efferent and one in the afferent loop of the jejunum. One tube was also placed through the pylorus into the duodenum.

The major portion of the opening in the stomach was then closed and the small gastrostomy opening was allowed to remain. This was brought up into the wound and fixed to the rectus sheath. The tubes were sutured to the wall of the stomach.

He improved temporarily, but on December 9 developed circulatory incompetency with cyanosis and dyspnœa, and died.

The pathological report on the specimen removed was: Gross examination: Specimen consists of part of the jejunum, which is the seat of a rather large, irregularly outlined ulcer. The lymph-glands in this region of the jejunum were extremely large and pressing against the wall so as to produce a bulging within the lumen of the gut.

Microscopic examination: Sections of the gland show chronic inflammatory tissue. Sections from the ulcer margin show chronic inflammatory tissue.

Diagnosis: Chronic lymphadenitis and chronic jejunal ulcer.

Etiology.—As yet no one has offered a satisfactory explanation of the etiology of peptic ulcer in general. Focal infection has been given consider-

able place in the factors to be considered, but why this should account for the almost universal occurrence of ulcer in the pyloric antrum and the first portion of the duodenum needs further elucidation. That that portion of the intestine which extends from the papilla of Vater to the aggregated lymph nodules of the intestine is singularly free from ulceration can be seen when I have been able to find only twenty-four cases of primary jejunal ulcer in the literature. The ulceration of the ileum which occurs in the various specific infections is the result of the invasion of the aggregate lymph nodules. The solitary lymph patches of the jejunum are not so prone to invasion in these diseases. Moreover, chronic ulcer rarely results after acute ulceration of the lymph follicles in the specific infections. Whatever the initial cause of the necrosis in the usual ulcer of the duodenum and stomach the acid gastric juice, although not the exciting cause, is surely a very definite contributory factor in maintaining its chronicity. In fact, it is probable that it is the deciding factor which explains the preponderance of chronic ulcers occurring above the entrance of the pancreatic ducts. Can this acidity be a factor in the primary jejunal ulcers?

The acid of the contents of the stomach is neutralized after passage into the duodenum. McClendon in estimating the pH of the lower part of the human duodenum found that this varied from 4.5 to 5.1 and in the ileum from 5.9 to 6.5. However, there is no hydrochloric acid present in the jejunum and the slightly observed acidity must be due to weakly dissociated acids. On the other hand, although hydrochloric acid has been neutralized and pepsin inactivated by the time that the chyme has reached the jejunum, proteolytic digestion takes place through the action of trypsin.

Yosaishimodaira believes that the jejunal ulcers are the result of an intense vaso-paralysis with local necrosis due to stasis and disturbed nutrition.

Whatever the cause of the local necrosis, tryptic digestion can act similarly to peptic digestion in preventing the repair of the ulcer by cicatrization.

It has been supposed by some that jejunal ulcer may occur after diseases that destroy the efficiency of the pyloric portion of the stomach or that interfere with the normal character of the gastric or duodenal secretion. Suffice it to say that with three agencies present in the intestinal tract to neutralize any excess acid, each of which possesses sufficient alkali to neutralize the hydrochloric acid of the gastric juice, it is highly improbable that peptic digestion as such plays any part in the occurrence of jejunal ulceration. In the jejunal or marginal ulcers which follow gastro-jejunostomy the acid gastric juice is undoubtedly a factor, but these secondary ulcers do not come within the scope of this paper.

Richardson recently, and Frankel earlier, have suggested the probability of syphilis as the cause of this lesion. It is well known that syphilis affects the jejunum more often than any other part of the small intestine. The tendency to form an ulcerated ring around the bowel and the frequency of perforation have suggested this etiology. Weiss found perforation seven times

in a series of thirty-four cases of intestinal syphilis. On the contrary, however, syphilitic ulcers are usually multiple and in the cases reported most of the ulcers have been single. Since the use of the Wassermann reaction or its modifications only one of the reported cases has had a positive reaction for syphilis.

Pathology.—These ulcers probably begin as acute ulcers and pass on to the chronic stage. The ulcers reported have as a rule been rounded and clear cut with punched-out edges. The mucosa is much more affected than the deeper tissues. In cross-section they have a terraced structure. This accounts for the fact that in the cases with perforation the serosal opening has been extremely small. In the jejunal ulcers there is apt to be considerable inflammatory reaction, so that enlarged mesenteric nodes, the result of chronic lymphadenitis, are fairly common.

In one of Richardson's cases and in three others in the literature besides our own, the ulcer caused an annular constriction. As a rule it affects a limited portion of the ante-mesenteric border of the jejunum. Since there is a marked chronicity in many of the operated cases, it is not unlikely that jejunal ulceration may be the forerunner of jejunal carcinoma.

Symptomatology.—I have found it exceedingly difficult to form a composite clinical picture of this condition from reported cases. Many of these have no clinical history in the reports and others are entirely inadequate. In those in which a complete history is given, the symptoms vary so widely that a definite clinical history of the composite type is difficult. The lesion occurs with greater frequency in the male, the ratio being about 7 to 2. The age varies from seventeen to fifty-seven, although the majority of the cases occur between the ages of thirty and fifty.

In many of the cases the history is similar to that seen in gastric or duodenal ulcer. A history of "stomach trouble" or "indigestion" lasting for a period of months or years is present in many of the reported cases. In other cases the symptoms were of exceedingly short duration, while in some perforation apparently was the first sign of an intra-abdominal lesion.

Pain, often associated with the ingestion of food, has been a predominant symptom. It is true that the onset of this pain is delayed for a period often much longer than that seen in the usual peptic ulcer. The ingestion of food has in some instances relieved the pain while in others, as in our case, this relief did not occur. It would appear from perusal of the reported cases that those patients obtaining relief after the taking of food had ulcers very close to the duodenal-jejunal flexure. The pain in many of the cases was in the mid-abdomen just above the umbilicus.

Very few of the reported cases sought relief until obstructive symptoms or perforation took place. In operating for obstruction or perforation of the alimentary tract, the jejuno-ileum must be considered as a possible site for the pathology. In the cases operated on for chronic ulcer of the stomach and duodenum and where no ulcer is found after careful inspection,

it would be advisable to inspect the upper jejunum. In several of the cases reported gastro-jejunostomy was performed in order to relieve the "dyspepsia" which was supposedly due to duodenal ulcer. In these cases the ulcer was distal to the jejunal loop which was used for the anastomosis, and it was some time later that the intestinal ulcer was found to be the real cause of the patient's trouble. Although vomiting is a frequent symptom in those cases having obstructive symptoms, hæmatemesis has never been noted.

In the perforated cases the location of the pain is at first in the mid-abdomen, but rapidly becomes generalized. The board-like rigidity which rapidly appears is like that seen in perforated peptic ulcer.

In the chronic cases the only possibility of diagnosis would appear to depend upon jejunal stenosis as demonstrated by the X-ray.

Treatment.—When the diagnosis is made there is no alternative to surgical treatment. Unlike peptic ulcer there is no so-called medical treatment. In those cases where an annular growth with enlarged mesenteric glands is found, the question of malignancy must be kept in mind. Such a case we have recently had and it so closely resembled the case I am reporting that it was not until the pathological report was obtained that we knew the difference in the two. Since so many of the reported cases have gone on to perforation, resection of the jejunum will offer the best opportunity of future well being.

CASES IN THE LITERATURE

Since the data of many of the reported cases is so meagre, I am giving the name of the author and a very few notes on each case.

1. Sestier, 1829, perforation, death.
2. Wagner, 1858, male, eighteen; trauma to abdominal wall, perforation and death; no operation.
3. Perroud, 1867, male, thirty-two; perforation and death; no operation.
4. Reverdin, 1867, male, fifty-five; perforation and death; no operation.
5. Parenski, 1876, male, forty-five; perforation and death.
6. Rufz, 1843, male, thirty-six; perforation and death; no operation.
7. Simpson, 1897, male, fifty-six; perforation and death; no operation.
8. Taylor, 1865, male, forty-five; trauma, perforation; death.
9. Brigidi, 1893, perforation of ulcers of jejunum and ileum; no operation; death.
10. Dodson, 1906, male, fifty-seven; trauma to groin, perforation and death; no operation.
11. Jankowski, 1908, male, forty-eight, perforation and death; no operation.
12. Hugh Lett, 1909, female, fifty-four; small perforation of chronic ulcer; suture; recovery.
13. Bryan, 1916, male, forty-eight; perforation; operation; death.
14. Murphy, 1916, male, sixty-two; operated for duodenal ulcer, but also found jejunal ulcer.
15. Richardson, 1922, male, forty-seven; perforation; excision of ulcer; recovery.
16. Richardson, 1922, female, forty-eight; perforation; enterectomy; recovery.
17. Cade, 1913, male, twenty-five; perforation; death.
18. Walton, 1922, female, forty-five; enterectomy; recovery.
19. Schoo, two cases found at autopsy.
20. Rotgans, 1909, found one in patient operated on for gastric ulcer.

21. Schmilinski, 1910, female, sixty-three; chronic stenosing ulcer; enterectomy; recovery.

22. Letulle, 1895, male, eighteen; perforation and death.

23. Kretschmer, 1920, male, thirty-nine; resection.

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OBSERVATIONS ON PEPTIC ULCER * (*Continued*)

IV. PATCH TRANSPLANTS OF JEJUNUM IN THE STOMACH †

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This study was made in order to determine the effect of surgical duodenal drainage on the mucosa of patches of jejunum of whole thickness transplanted into the wall of the stomach. Patches of jejunum with intact circulation were substituted for several different portions of the gastric wall. The fate of these patches was studied for long periods both before and after surgical duodenal drainage, an operation known to produce ulcer of the duodenum and jejunum.

Takats and Mann have reviewed the work of previous workers in this field and studied numbers of jejunal patch transplants in the stomachs of dogs and found them quite satisfactory. In their experiments they found very few ulcers and those only on patches situated on the lesser curvature of the stomach near the pylorus.

In a previous paper I reviewed some of the many procedures that have been devised to produce ulcers in the gastro-intestinal tracts of experimental animals. Acute lesions have been induced by many investigators but few have been able to produce chronic types of ulcer. Probably the most successful procedure was described by Mann and Williamson, who devised an operation for surgical duodenal drainage which induced typical chronic peptic ulcers in dogs in more than 90 per cent. of experiments. These ulcers were produced in the duodenum and jejunum and were grossly and microscopically almost indistinguishable from peptic ulcers encountered clinically. I also reported the production of peptic ulcers in the stomachs of dogs. In my experiments peptic ulcers of the jejunum occurred in almost 100 per cent. of cases following surgical duodenal drainage, and when areas of gastric mucosa were excised following the operation for surgical duodenal drainage, healing of the denuded areas was always delayed. The delay in healing was most marked in denuded areas on the lesser curvature and in more than 50 per cent. of these experiments typical chronic peptic ulcers developed in denuded areas on the lesser curvature. In other previous papers I reported work done on various other phases of experimental production of chronic peptic ulcers.

Method of Experimentation.—Because surgical duodenal drainage retarded the healing process in the stomach and frequently induced ulceration in denuded areas on the lesser curvature, I performed a series of

* See Annals of Surgery, February, 1927, vol. lxxxv, p. 207.

† Submitted for publication, February 7, 1927.

experiments to determine how surgical duodenal drainage would affect patches of jejunum transplanted into various portions of the wall of the stomach. All experiments were performed on normal, healthy dogs and for all operative procedures ether anæsthesia and aseptic technic were employed. No rubber-covered or other intestinal clamps and no unabsorbable sutures were used in any of the operations.

All animals were used first for control experiments. A patch of jejunum was transplanted into various portions of the wall of the stomach; the lesser curvature, greater curvature, anterior wall and posterior wall. Patches were obtained by resecting a loop of jejunum about 5 cm. in length with its mesenteric circulation carefully preserved. The loop of jejunum was then split longitudinally opposite its mesenteric attachment and trimmed to an approximately circular shape about 5 cm. in diameter designed to replace a resected area of gastric wall of similar size and shape. The patch was sutured into place with its own mesenteric circulation intact and the continuity of the intestine was reëstablished by end-to-end anastomosis. Following this operation animals were kept for long periods. They received the usual care and regular diet of normal dogs. All of them remained in excellent condition.

FIG. 1.—Photograph of stomach showing typical peptic ulcer in jejunum following surgical duodenal drainage and typical peptic ulcer in patch in lesser curvature.

At various intervals after the first operation the condition of the patch of jejunum was carefully observed at laparotomy. Frequently at the same laparotomy the operation for surgical duodenal drainage into the ileum was performed as described by Mann and Williamson and repeated by me.

Following this operation animals were carefully observed for evidence of ulcer. Milk and syrup were added to their diet for the maintenance of normal nutrition. Most of the dogs remained in good condition until the ulcer (which developed at the usual site in the jejunum) became a definitely chronic lesion. From large series of experiments with surgical duodenal drainage it has been found that the dog's nutrition, except for an initial decrease in weight immediately after operation, does not decline appreciably until the ulcer in the jejunum has progressed to a considerable degree of chronicity. Final observations on the condition of the jejunum and of the stomach with its patch of jejunum were made at necropsy.

Results.—There were twenty-one experiments in which patches of jejunum of whole thickness were transplanted into the wall of the stomach. In thirteen of these experiments the patch was inserted in the lesser curvature of the stomach near the pylorus. In the remaining eight experiments the patch was placed in various other regions of the stomach. Patches were observed at various intervals from thirty-six to four hundred and nineteen days following their transplantation.

In only one case was an ulcer found in any of the twenty-one patches. This was an ulcer 1.5 by 0.7 cm. found at necropsy one hundred and sixty-three days after the patch had been transplanted. The patch in which this ulcer was found had been placed on the lesser curvature near the pylorus. (Table I.)

TABLE I.

Series of Jejunal Patches.

Dog	Patch placed in stomach, date of operation	Situation of patch in stomach	Patch explored, date of operation	Condition of patch	Time interval, days
1	1–30–25	Lesser curvature near pylorus	3–25–26	Normal	419
2	7– 9–25	Lesser curvature near pylorus	2– 1–26	Normal	175
3	7–27–25	Lesser curvature near pylorus	2– 1–26	Normal	157
4	7–27–25	Lesser curvature near pylorus	2– 1–26	Normal	157
5	7–28–26	Lesser curvature near pylorus	1– 7–26	Ulcer on patch, 1.5 by 1 cm.	163
6	7–28–26	Lesser curvature near pylorus	9– 2–26	Normal	36
7	7–29–25	Lesser curvature near pylorus	2– 4–26	Normal	190
8	8– 7–25	Lesser curvature near pylorus	2– 4–26	Normal	181
9	9– 7–25	Lesser curvature near pylorus	1–20–26	Normal	135
10	9– 7–25	Lesser curvature near pylorus	1–22–26	Normal	137
11	9– 7–25	Lesser curvature near pylorus	1–25–26	Normal	140
12	9– 9–25	Lesser curvature near pylorus	1–25–26	Normal	138
13	9– 9–25	Lesser curvature near pylorus	1–20–26	Normal	133
14	3– 9–26	Anterior wall near pylorus	6– 7–26	Normal	90
15	3–10–26	Anterior wall near pylorus	6– 7–26	Normal	89
16	3–10–26	Middle of anterior wall	6– 7–26	Normal	89
17	3–11–26	Middle of posterior wall	6–10–26	Normal	91
18	3–18–26	Middle of posterior wall	6–10–26	Normal	84
19	3–23–26	Middle of greater curvature	7– 1–26	Normal	100
20	3–23–26	Anterior fundus region	6–11–26	Normal	80
21	3–23–26	Anterior fundus region	6–11–26	Normal	80

In thirteen experiments surgical duodenal drainage was instituted after transplanted patches of jejunum had been normal for from eighty to four hundred and nineteen days. In five of these experiments the patches had been inserted in the lesser curvature near the pylorus. In three of this number typical chronic ulcers were found in the patches at necropsy seventy-seven, thirty, and thirty-nine days, respectively, following surgical duodenal drainage. (Fig. 1.) In the remaining eight experiments in which the patches had been placed in various other sites in the stomach (Fig. 2) only one ulcer was found following surgical duodenal drainage. This was not a chronic ulcer but was merely a small superficial erosion found in a patch in the anterior wall. (Table II.)

TABLE II.

Series of Jejunal Patches After Duodenal Drainage.

Dog	Jejunal patch		Duodenal drainage, date of operation, 1926	Date of necropsy, 1926	Condition of patch	Time interval, days	Ulcer in jejunum
	Situation in stomach	Duration, days					
1	Lesser curvature near pylorus	419	3–25	6–22	Normal	89	None.
2	Lesser curvature near pylorus	175	2– 1	4–19	Ulcer 2 by 1.5 cm.	77	None.
3	Lesser curvature near pylorus	157	2– 1	3 –3	Ulcer 2 by 1.5 cm.	30	1 by 1 cm.
4	Lesser curvature near pylorus	157	2– 1	3–12	Two ulcers, one perforated	39	2 by 1 cm.
5	Lesser curvature near pylorus	190	2– 4	3– 5	Normal	29	1.5 by 1.5 cm.
6	Anterior wall near pylorus	90	6– 7	7– 5	Normal	28	None.
7	Anterior wall near pylorus	89	6– 7	7–30	Normal	47	Perforating ulcer, 1 cm.
8	Middle of anterior wall	89	6– 7	7– 5	Normal	28	Perforating ulcer, 3 by 2 cm.
9	Middle of posterior wall	91	6–10	7–30	Normal	50	1 by 1.5 cm.
10	Middle of posterior wall	84	6–10	7–30	Normal	50	3 by 3 mm.
11	Middle of greater curvature	100	7– 1	7–30	Normal	29	8 by 8 mm.
12	Anterior fundus region	80	6–11	6–18	Normal	7	None.
13	Anterior fundus region	80	6–11	6–29	Superficial erosion	18	2.5 by 2 cm.

Discussion.—These experiments show that there is a definite tendency toward the formation of peptic ulcer on the lesser curvature of the stomach. Patches of jejunum transplanted into various portions of the wall of the stomach, and thus subjected to an unfavorable acid environment, when observed for long periods remained normal except in one case. In this case

a chronic peptic ulcer developed in a patch in the lesser curvature of the stomach. Patches which had remained normal for long periods in spite of the unfavorable acid environment in the stomach were then subjected to conditions produced by surgical duodenal drainage. Except for a superficial erosion in a patch implanted in the anterior wall of the stomach, ulcers developed only in patches in the lesser curvature of the stomach. Typical chronic ulcers developed in three of five patches in this situation.

The formation of ulcer in jejunal patches following duodenal drainage indicates that the environment of the jejunal transplants had been rendered

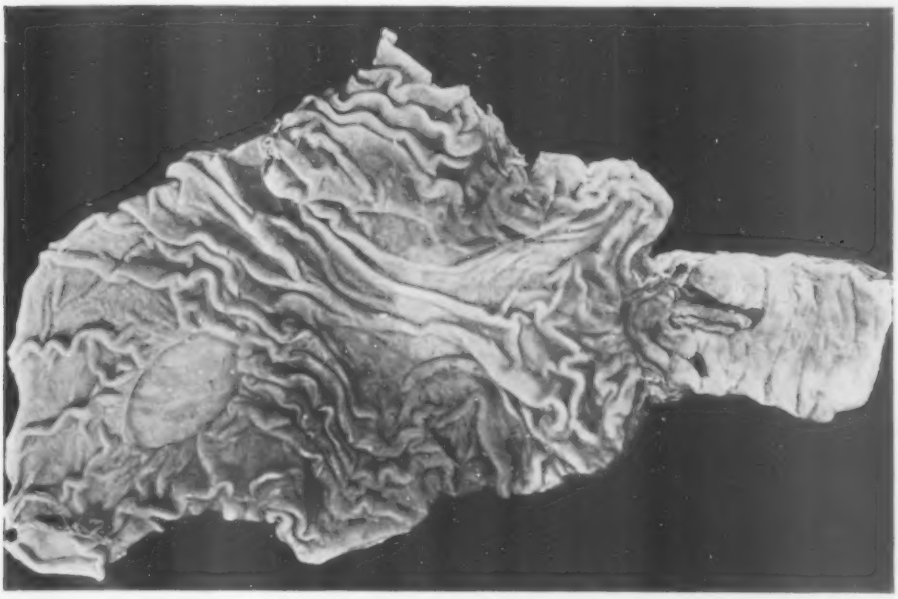

FIG. 2.—Photograph of stomach showing typical peptic ulcer in jejunum following surgical duodenal drainage and normal patch in anterior wall.

still more unfavorable, and may be fairly attributed to that disturbance of acid-alkali balance in the stomach which duodenal drainage might be expected to induce.

These findings are in accord with clinical statistics which show that a very high percentage of all ulcers of the stomach occur on the lesser curvature. They are also in accord with data of experiments previously reported by me in which I found that surgical duodenal drainage had a very marked effect on the process of healing in the stomach. Areas denuded of mucosa in various regions in the stomach healed readily under normal conditions, but when subjected to the acid-alkali imbalance in the stomach caused by surgical duodenal drainage showed marked delay in healing. Areas on the greater curvature healed completely while areas on the lesser curvature healed very sluggishly and went on to chronic peptic ulceration in as high as 62.5 per cent. of prolonged experiments.

The lesser curvature is the "Magenstrasse," the gastric street, as

expressed by Aschoff and others. It bears the brunt of the mechanical trauma administered to the gastric mucosa in the process by which the forces of muscular contractions empty the stomach. The stomach impels ingested material most directly along the lesser curvature to expel it through the pylorus and the lines of force exerted by the contracting gastric musculature tend to converge along the lesser curvature.

The acid-alkali imbalance in the stomach resulting from surgical duodenal drainage and the relatively exposed position of the lesser curvature in relation to trauma in the emptying process in the stomach seem to be important factors in explaining the presence and site of the ulcers found in these experiments. The patch of jejunum transplanted into an environment to which it was not accustomed may well have served as a point of least resistance. The importance of these factors in cases of clinical peptic ulcer is suggested by the close parallel between clinical statistics and experimental data.

SUMMARY

Some of the previous work on autoplastic transplantation of patches of jejunum into the walls of the stomach and on the experimental production of peptic ulcers has been reviewed.

Twenty-one experiments on dogs were described in which patches of jejunum with intact mesenteric circulation were transplanted into the wall of the stomach at various points and observed for periods as long as four hundred and nineteen days. All patches remained in normal condition except one. In this case a chronic peptic ulcer developed in a patch in the lesser curvature of the stomach.

Thirteen experiments were described in which patches that had remained normal for long periods up to four hundred and nineteen days were subjected to the acid-alkali imbalance in the stomach resulting from surgical duodenal drainage. Patches were in various regions of the stomach. Except for a superficial erosion which developed in a patch in the anterior wall of the stomach ulcers developed only in patches in the lesser curvature. Typical chronic ulcers developed in three of five patches in this situation.

The acid-alkali imbalance in the stomach and adjacent intestine resulting from surgical duodenal drainage and the relatively exposed position of the lesser curvature in relation to trauma in the emptying process in the stomach were suggested as important factors in explaining the presence and site of the ulcers found in the experiments. The possible relation of these factors to clinical problems was mentioned.

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MESENTERIC CYSTS*

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Cysts of the mesentery are interesting because of their history, rarity, origin and disputed classification, the infrequency of their being diagnosed and as a cause of intestinal obstruction.

The first case, a female child, who had intestinal obstruction as a result of the cyst occluding the bowel, was an enterogenous cyst operated upon May 5, 1924. The second, an adult male, was operated upon by Dr. Charles F. Mitchell, March 26, 1925. This sac contained a sebaceous-like material and was thought to be a dermoid. Other cases have been reported by fellows of the Philadelphia Academy of Surgery: Dr. H. C. Deaver,[1] Congenital mesenteric cysts, 1909. Dr. Charles H. Frazier,[2] Mesenteric cysts with a report of a case of sanguineous cyst of the mesentery of the small intestine, 1913. Dr. Thomas A. Shallow,[3] Entero-mesenteric cysts, April, 1925. Dr. William J. Ryan,[4] Omental cysts, October, 1926.

History.—Their history has been divided by Braquehaye[5] into three periods, and Ney and Wilkinson,[6] in 1911, suggested a fourth.

First Period.—The first case recorded was by Benevieni, a Florentine anatomist, in 1507. He found it accidentally at autopsy, and characterized it as an anatomical marvel. Tulpio, Morgagni and others, from that time until about 1850, reported cases, but in each instance, the tumor was discovered only at the post mortem.

Second Period.—From 1850 to 1880, a few were treated by operation, but almost invariably upon a wrong diagnosis and with a uniformly fatal result.

Third Period.—From 1880 to the present time. Many were reported in which a diagnosis was made before celiotomy and were then treated with good results chiefly by French surgeons, among whom Pean, Millard, Tillaux, and Merklen were especially worthy of mention.

Ney and Wilkinson, in 1911, suggested a *Fourth Period* from 1900 to the present time, commencing at the time of Dowd's[7] interesting theory—"The origin of mesenteric cysts from embryonic sequestration," and extending to the present day.

Cysts of the mesentery are among the *surgical rarities.* In text-books, the subject is either omitted altogether or dismissed in a few brief sentences. However, Dowd states that reports indicate that mesenteric cysts are being removed at least as often as once a month and if microscopical examination of their walls and chemical and microscopical examinations of the contents are made, the entire subject should be soon understood. Cystic tumors of

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the mesentery are probably more uncommon than similar lesions of any of the other structures of the abdominal cavity.

In 1886, Augagneur[8] found that 18 out of 90 cases of tumors of the mesentery were cystic. Arekion,[9] 1891, gave reference to 81 reported cases. In 1892, Braquehaye (*loc. cit.*) added 23 to his number, making 104. In 1897, Moynihan[10] reported nine additional cases and Dowd (*loc. cit.*) in 1900, collected from literature 32 cases. This makes a total of 145 cases. Dowd, however, stated that many of these are not reported sufficiently in detail to make them really intelligible.

Edward G. Jones[11] says that Lawson Tait is said never to have seen a mesenteric cyst and Spencer Wells only two. Dr. L. L. McArthur, of Chicago, stated in 1912 that he had never seen a chylous cyst of the mesentery and quotes the late A. H. Ferguson as having the same experience. In 1912, Friend,[12] of Chicago, collected fifty-two cases of the chylous type and in 1913, A. L. Benedict,[13] of Buffalo, supplemented Friend's list, bringing the total to ninety-six. The chylous type embraces approximately one-half of the mesenteric cysts, so that about 200 in all can be found in medical literature.

F. Rosenbladt,[14] in 1915, stated that about 200 isolated cases were recorded in literature. This excludes omental cysts which are usually classed under mesenteric cysts and are, no doubt, similar in structure and origin. Doctor Ryan states that there have been but forty-four cases of omental cysts reported since 1852, when Gairdner reported an autopsy specimen before the Pathological Society of London. Cysts may occur in the various parts of the mesentery. Dowd (February, 1921) stated that no case has occurred in the mesentery of the appendix, but one sees no reason why it should not occur there as well as in any other region of that structure and in all probability many have been found there. In reviewing the literature, I have found that in 1913, Willems, W.,[15] reported a dermoid cyst between the layers of the mesoappendix.

Carter,[16] in his article in 1921, says that there have been between two and three hundred cases reported including all varieties.

Higgins and Lloyd,[17] in July, 1924, stated that about 250 cases have been published, chiefly by surgeons, since the first case described by the Florentine anatomish Benevieni, in 1507.

The *genesis* of mesenteric cysts was a very obscure subject until rather recent years. A considerable amount of speculation has been indulged in an attempt to explain the origin of the cystic tumors of the mesentery. The ideas of the older pathologists were indefinite. Such cysts were attributed variously to lymph stasis, with resultant dilatation of a lymphatic gland or vessel, and to cystic degeneration of a lipoma or tuberculous glands. Rokitansky[18] in 1842, Moynihan in 1897, and Dowd in 1900 have each offered theories. Dowd's article aroused renewed interest in this subject, and recent work has resulted in a very considerable increase in our knowledge, though even now there is no general agreement of the writers.

We can determine the nature of a cystic tumor by studying the life history, its location, the structure of its wall and the character of its contents. Classifications have been based upon these findings.

The first formal description of such a cyst was made by Rokitansky in 1842. Subsequently, Brucy and Rokitansky each described a number of these cysts and each endeavored to prove their origin from degenerated lymph-nodes. To this, singularly enough, Virchow,[19] 1887, agreed. In 1892, Braquehaye (*loc. cit.*) classified mesenteric cysts as (a) sanguineous; (b) lymphatic cysts, including chylous cysts; (c) hydatid

cysts; (d) congenital and dermoids; (e) cysts of adjoining organs, ovaries, pancreas, etc. In 1897, Moynihan (*loc. cit.*) classified them as (a) serous; (b) chylous; (c) hydatids; (d) blood; (e) dermoid; (f) cystic malignant disease.

In 1900 appeared Dowd's widely quoted paper in which he divided mesenteric cysts according to what he believes to be their origin into (a) Embryonic, including—1. Dermoids, 2. Serous, 3. Chylous, 4. Hemorrhagic, 5. Cysts with walls like that of intestines, (b) Hydatid, (c) Malignant disease.

He successfully removed from the transverse mesocolon of an adult woman a cyst which closely resembled in detail a multilocular ovarian cystoma. The ovaries of this patient seemed normal on palpation. In presenting this case, he pointed out the close anatomical relationship existing in embryonic life between the Wolffian body or germinal epithelium and the root of the mesentery, and suggested the possibility of the sequestration from the germinal epithelium of a group of cells which might be displaced by the subsequent growth of the individual in such a way as to take up an intramesenteric position; later on, perhaps, during the adult life, such a sequestrum from the germinal epithelium might develop into a tumor similar to the one he removed. Going further, he suggests that small portions of the developing gut may be similarly sequestrated to lie perhaps between the leaves of the mesentery and later develop into a cyst. The emphasis laid on the probably embryonic origin of a large number of mesenteric cysts represented a decided advance in our knowledge of this subject. Since Dowd's paper, this idea has been repeatedly emphasized and elaborated.

In 1902, Moynihan (*loc. cit.*) also expressed the opinion that most of such cysts originate from embryonic remnants.

In 1906, Ayers, J. C.,[20] expressed himself as of the same opinion but simplified Dowd's classification by adding two more groups, (a) cysts arising from the glandular structure of the intestinal wall, (b) cysts of the normally placed retro-peritoneal organs.

In 1907, Niosi,[21] in an excellent paper, states his belief that about one-half of all mesenteric cysts are acquired and places the so-called lymphatic and chylous cysts in this group. Klemm,[22] on the other hand, in 1905, found the wall of the lymphatic mesenteric cysts to be made up wholly of those cells which arise from the mesoderm, and argues that these cysts are neoplasms developing from misplaced or sequestrated portions of the mesodermic tissue, and hence form a group of tumors of embryonic origin for which he proposes the name of "mesodermoids," by way of analogy to that group of tumors called dermoids.

Niosi divided embryonic mesenteric cysts as follows:

1. Cysts of intestinal origin, (a) Sequestrations from bowel during development, (b) From Meckel's diverticulum. 2. Dermoids. 3. Cysts from retroperitoneal organs (germinal epithelium, ovary, Wolffian body, Mullerian duct).

In 1909, Deaver, H. C., agreed with Dowd that all such g[illegible]hs [illegible]ith the exception of parasitic and malignant cysts, are of embryonic origin.

Eric Gould, also in 1913, approved of Dowd's simplified classification, but because of several cases of chronic abscesses that he had seen in the mesentery of tuberculous nature, he suggested that the simplest and most correct pathological grouping is into the three classes as follows:

1. Cysts arising in embryonic remnants and sequestrated tissue, (a) Serous, (b) Chylous, (c) Sanguineous, (d) Dermoids, (e) Cysts from intestinal diverticula. 2. Cysts of infective origin, (a) Hydatids, (b) Tuberculous abscesses. 3. Malignant cysts.

In 1913, Miller,[23] in a most complete article on "Enterogenous Mesenteric Cysts," states that the idea that a portion of an embryonic tissue or organ may become sequestrated and still continue to develop though usually in an anomalous manner, is a familiar one. Bauer[24] credits Verneiul and Remak with the first proposal of this idea, while quoting Ribberts' expression of the theory as the best. A free rendering of this passage from Ribberts is perhaps not superfluous. Epithelial cysts may be formed not only

as a result of trauma, but also by abnormal development; irregular growth may cause a change of position or a changed relationship without actual change of position; or, again, epithelial structures which should coalesce fail to do so, or finally, those which should decrease in size, or disappear entirely retain their maximum dimensions. A group of epithelial cells with its connective-tissue support is rendered more or less independent in growth by either of these processes and thenceforth develops as a cyst whose lumen is constantly enlarged by the retention of its own secretion and desquamated epithelium, although this increase in size is usually extremely slow and scarcely noticeable. When suggesting this process to explain the enterogenous origin of certain mesenteric cysts, Dowd argues by analogy, instancing, the comparative frequency with which a typical development results in an accessory thyroid, spleen, or pancreas. The actual process of sequestration from the developing gut was not observed until 1908, when there appeared a report from Lewis and Thyng in which they described the "regular occurrence of intestinal diverticula in embryos of the pig, rabbit and man." Previous to this time, Lewis had discovered a "knoblike outpocketing of the intestinal epithelium a short distance beyond the pancreas" in a rabbit embryo, while Thyng had found a similar structure in a human embryo of 13.6 mm. and had interpreted it as an accessory pancreas. Lewis and Thyng have thus established the fact that the formation of diverticula and cysts is a regular occurrence in the embryonic development of the gut. There can be scarcely a doubt that such a cyst may occasionally persist to be recognized after birth as a "mesenteric cyst."

While the findings of Lewis and Thyng account for a certain number of mesenteric cysts, there is a general agreement among those who have studied this question that most juxta-intestinal cysts, even when intramesenteric in position, have their origin in the vitelline or omphalo-mesenteric duct or in Meckel's diverticulum.

It is apparently established that Meckel's diverticulum or persistent remnants of the omphalo-mesenteric duct may give rise to a mesenteric or juxta-intestinal cyst along practically the entire course of the small bowel, though such an occurrence must be exceedingly rare in the extreme upper limits of the bowel.

Miller suggests certain general features which may aid one in determining whether a cyst represented the process of sequestration from the bowel as described by Lewis and Thyng, or whether it developed from Meckel's diverticulum or the persistent remains of the omphalo-mesenteric duct. Manifestly, the problem presents many difficulties and is wholly impossible.

A mesenteric cyst of either of these two types (Lewis and Thyng's embryonic cysts and the omphalo-mesenteric duct) arises from the bowel whose structure it shares; such a cyst, when typical and unaltered by inflammation, presents certain features which are quite characteristic and easily recognized. The resemblance to the adjacent bowel may be little short of exact, in that there is found a mucosa with typical glands, goblet cells and ciliated cells, well developed villi, a distinct submucosa and two layers of smooth muscle placed at right angles to each other. The picture, however, is usually not so clear. The widest variations from the typical are found in the epithelial linings. The wall of a typical enterogenous cyst shows two well-developed layers of smooth muscle running at right angles to each other as they do in the bowel wall.

Arguments based on cellular structure must take into account the possibility of histological alterations in the wall of a cyst, for such changes could readily obscure the picture; inflammation can substitute scar tissue for any other tissue.

In 1915, Jones, E. G.,[31] likewise agrees that there is a growing tendency to regard most mesenteric cysts as having their genesis in embryonic rests.

In 1921, R. M. Carter suggested another classification though evidently based on Dowd's as follows:

1. True mesenteric cysts, subdivided according to their probable origin into (a) Embryocystomata; (b) Enterocystomata, by which I understand not only tumors of

Meckel's diverticulum, but also tumors arising from sequestrations from the bowel; (c) Obstructive possibly. 2. Dermoids. 3. Cystic malignant disease. 4. Parasitic.

By applying this classification to all cystic tumors of the mesentery, Carter believes that more uniformity of description would at least be obtained than at present exists in the literature.

It is plain that more and more are coming to regard all mesenteric cysts not parasitic or malignant, as of embryonic origin. The term "cystic malignant disease" which has been given as a class of mesenteric cysts is no longer tenable. Malignant cysts are probably for the most part originally simple cysts which subsequently have become malignant. Moreover, a metastatic malignant tumor of the mesentery or, for that matter, a primary one which undergoes cystic degeneration is not morphologically a cyst.

Some anomalous and hitherto unclassified cysts are true mesenteric cysts which have developed from meso-dermal remnants behind the peritoneum but which, unlike the ordinary clinical mesenteric cyst, have not moved anteriorly into the developing peritoneal folds.

It is important to distinguish the cysts of which we speak from the large cysts of the kidney which occur generally singly and quite apart from chronic nephritic, congenital cystic disease, and echinococcus infection; these are cysts of the kidney substance proper, and may communicate with the pelvis or contain fluid closely allied to urine, whereas the pararenal variety is definitely outside the kidney, and, though they may indent its substance, are not attached to it, and contain the characteristic fluid previously described. Pararenal cysts are very rare, and have received scant notice in the text-books. There is no mention of them in *Keen's Surgery* and only a few lines in some of the standard works on urology. Thus, Morris, Garceau, Thomson, Walker and Kidd all refer briefly to them, and allude to a possible origin from Wolffian body remnants; but no attempt seems to have been made to associate them particularly with mesenteric cysts, nor does their close resemblance, and that of their contents, to mesenteric cysts seem to have received due notice.

Many writers speak of true mesenteric cysts as not being malignant, parasitic or dermoid.

Dowd, in speaking of "dermoid cysts," as well as many others, believes them always to be due to an error in development in the ovary or some one of the epithelial structures. They occur chiefly in the abdomen and in places where skin-covered surfaces coalesce during embryonic life. When in the abdomen, they are believed to be of ovarian origin. There have been records of several mesenteric dermoids. Gould, in 1913, stated that about 23 dermoids had been reported in an article written in 1908. Since that time, we have found at least twelve others reported, making a total of thirty-five to the present time. Schultzer records one in which two canines, two incisors and eight molars were present. Mayer describes a dermoid larger than a man's head which was taken from the mesentery; it was free from the genitals. The inner cyst wall was smooth and shiny and beset with long black hair; the fluid was yellowish-brown similar to pea soup.

Spencer Wells removed from between the folds of the mesentery one which contained bundles of fine hair and six pounds of fatty material and flattened epithelium. Langton removed a dermoid from between the layers of the mesentery and another

from each ovary. Konig states that he has observed a dermoid cyst in the mesentery. These cysts are all believed to be of embryonic origin and I know of no other theory which explains their formation.

Ney and Wilkinson and others have noted that all mesenteric dermoids reported have occurred in females and, therefore, conclude that all are of ovarian origin. Higgins and Lloyd (*loc. cit.*), 1924, also state that no retroperitoneal or mesenteric dermoids have been reported in the male, though they have occurred in the testis which is originally a retro-peritoneal organ. This has been held as evidence that an ovary is responsible for the true dermoid when it occurs in the mesentery.

Moynihan, 1897, says that cystic disease of the mesentery is very much more common in women than in men. The only form of cyst found with perhaps equal frequency in the two sexes is the hemorrhagic cyst as one might suppose from the mode of origin. Dermoid cysts have been found only in women. The extremes of life are not exempt from the disease. Cases are recorded at the age of four months (Lucassett and Winiwarter) and at the advanced age of eighty years.

In 1913, Willems, W., reported a case. Dermoid cysti zwishen den Blattern der Mesoappendix.

Symptomatology and Diagnosis.—There are no signs or symptoms which are pathognomonic of mesenteric cysts but given a tumor in the abdominal cavity which is smooth, rounded and cystic and unusually mobile as in our first case, we should think that the diagnosis would be easy. That the diagnosis of mesenteric cysts is difficult, is proved by the fact that no case has been recognized with certainty previous to operation or autopsy. In a typical case, the mobility of the tumor is the striking feature. Other symptoms are the result of pressure on the bowel with resultant pain and obstruction symptoms. Porter says that pain is more frequent with this condition than with any other type of abdominal cystic tumor. A history of repeated attacks of abdominal pain associated frequently with vomiting and often with alternating periods of diarrhœa and constipation is significant. These attacks are presumably due to increased peristalsis, in an effort to overcome the narrowing of the bowel produced by the encroachment of the cyst upon its lumen or they may be due to attacks of partial volvulus. This narrowing may occasionally be so great as to cause absolute obstruction; a volvulus may also become complete. Strangulation and gangrene of the gut due to pressure have occurred.

General wasting is not a characteristic symptom even when a large tumor is present and obstruction of the lacteals might be expected. Small cysts may give rise to no symptoms whatever, unless, for some cause or other, an acute inflammatory condition arises. Under such circumstances, the symptoms are similar to other acute abdominal conditions and must be differentiated. As the cyst becomes larger, they must be differentiated, from ovarian cysts, retroperitoneal growths, hydronephrosis, movable kidney, pancreatic cysts, new growths of the intestine and the pregnant uterus.

The differential diagnosis may be considered briefly under two heads as described by Higgins and Lloyd: 1. Diagnosis from other intra-abdominal tumors. 2. Diagnosis between individual cysts.

In a typical case, the situation, mobility and general characters of the

tumor may localize it with probability to the mesentery, and serve to distinguish it from other abdominal swellings. Its cystic character may also be surmised. It should usually be possible to exclude parasitic and malignant cysts, but a tuberculous abscess in the mesentery may present all the features enumerated above, and indeed, in childhood at any rate, is the most common type of "mesenteric cyst" to be exposed by operation.

Though it is admittedly a very difficult diagnosis to make, yet, there are cases where, once suspected, a mesenteric cyst should be diagnosed. Obviously, the attempt ought always to be made.

Complications.—1. Intestinal obstruction is the most frequent and the most serious of the common complications. In a small series of 17 enterogenous cysts, acute obstruction occurred in nearly 50 per cent., whilst the group mortality of 35 cases of obstruction due to this cause was 35 per cent. The methods by which it may be brought about are mechanical, and include volvulus, intussusception, kinking, adhesions, and narrowing or occlusion of the intestine over it.

2. Peritonitis, when it occurs, is a sequel to the above.

3. Hemorrhage into the cyst has caused death.

4. Rupture of the cyst may also cause death (Timbal [26]); but there are two cases of recovery following what seems to have been spontaneous rupture of the cyst into the bowel.

5. Torsion of the cyst.

6. If a mesenteric cyst occupies the pelvis, it may itself become impacted or may give rise to symptoms varying with the organ upon which it presses.

The *treatment* of mesenteric cysts may be covered in a few words as described by Miller. In the group of acute cases we are dealing always with intestinal obstruction or peritonitis and the treatment is directed toward these conditions primarily and the operation is an emergency.

In the second group, the latent cases, the operation is an elective one and choice is to be made between—1. Drainage. 2. Enucleation, and 3. Resection. *Drainage* is attended by a very low primary mortality but is apt to result in a persistent sinus, which will ultimately require excision, and, hence, is not altogether desirable. Without differentiating the type of cyst dealt with, Coley [27] has estimated the mortality following drainage at 6 per cent. This probably includes some deaths due to complications and seems a very high rate.

Enucleation was done ten times without a death in 16 cases. This is undoubtedly the procedure of choice when it is feasible. The cyst may be part and parcel of the intestinal wall, when it is impossible to enucleate without opening the gut. Enucleation of a cyst or multiple cysts may do irreparable damage to the circulation of the bowel, enforcing resection. Dense adhesions may render enucleation impossible without tearing the bowel. The cyst may occupy an intra-intestinal position, as in several reported cases, near the ileo-cæcal valve and even be drawn into the cæcum, simulating an intussusception. In such circumstances, the bowel must be

opened to expose the cyst. These conditions among others may compel resection.

In five cases of *resection* of Miller's series, there were three deaths, a mortality of 60 per cent. So high a mortality is due partly to the serious condition of most of these patients, but the figures serve in a general way the relative safety of enucleation of the cyst as compared to resection of the bowel.

Undoubtedly, the best treatment is *enucleation* when it can be done without seriously injuring the bowel.

Aspiration has no place in modern surgery, although it was the favorite procedure with the older surgeons.

Marsupialization is also obsolete, and properly so, unless in very exceptional instances.

CASE I.—M. B., female child, age seven, private patient in the Germantown Hospital. Admitted April 25, 1924. Discharged cured May 5, 1924.

Eight days before admission to the hospital, the child began to have attacks of pain in the upper abdomen with vomiting. These pains became progressively worse, were paroxysmal and followed with vomiting. The day before admission, the vomiting increased in severity and was fecal. The bowels had not moved for three days and there was no flatus expelled during the last twelve hours. The mother stated that the child had several attacks somewhat similar in character and that constipation had existed for years. She also noticed that the child's abdomen was enlarged but thought the swelling disappeared as she recovered from the attacks.

Physical examination revealed a fairly well-developed girl. The tongue was coated. The heart and lungs were normal. The abdomen was enlarged and tympanitic to percussion. In the upper left quadrant there was a mass about the size of a small grape fruit. This mass was freely movable and when first felt was found in the midline in the bladder area. It was regular in outline and smooth and cystic to touch and dull to percussion. By palpation of the mass we noticed that it had suddenly disappeared from the midline into the left upper quadrant and had almost disappeared under the ribs. By further manipulation we found that we could displace the tumor and place it over into the right upper quadrant beneath the ribs. There was some tenderness over the mass and slight rigidity of the abdomen.

Before operation, temperature was 99°; pulse, 96; respirations, 24. The leucocyte count was not made. Urine, clear amber, acid. Specific gravity, 1.012; albumen negative; sugar negative; acetone negative; white blood-cells 3 to 8 to H. P. F.; occasional hyaline casts; amorph. urates.

Dr. Charles F. Mitchell saw this child in consultation with Dr. Walter Andrus and myself. Previously, the child was seen by a pædiatrician. We all agreed that the tumor mass was causing an intestinal obstruction. Three of us agreed that it was cystic and the pædiatrician made a provisional diagnosis of intussusception. One diagnosis was omental cyst and another ovarian cyst and the third indefinite.

Under ether anæsthesia a median incision was made below the umbilicus about four inches long. With some difficulty a movable cyst was brought into the field of operation and delivered. It was found to originate from the mesentery of the ileum and about the size of a small grape fruit. It was occluding the portion of the bowel attached. A trocar was plunged into it and 200 c.c. of a dark bloody colored fluid was removed. The peritoneum was incised at its base and with gauze, the peritoneum was stripped from the sac and the wall enucleated. This portion of the bowel was collapsed and congested. The distal portion of the bowel was collapsed and the proximal distended. The mesentery was carefully repaired. The blood supply to the bowel was

preserved; peristalsis was noticed in the bowel; the abdomen was closed without drainage.

The recovery was uneventful. The bowels moved normally several days after operation and the child left the hospital on the tenth day cured.

The *microscopical examination* of a section of the cyst wall showed it composed of three coats, an inner serous, a middle muscular with bands going in two directions, some lymph-tissue scattered between these two coats. The inner was a thick fibrous envelope undergoing calcareous changes.

A section from another portion of the wall shows the same three coats, the inner one composed of a hypertrophied endothelium.

The laboratory report on the contents of the cyst—290 c.c. of a dark bloody-colored fluid; culture, sterile. No chemical tests made. The fluid most likely was blood, serum or lymph.

CASE II.—Private patient of Dr. Charles F. Mitchell. S. W., male, age twenty-six; Chestnut Hill Hospital. Seen with Doctors Cheston and McCloskey, February 8, 1925.

In July, 1924, Doctor McCloskey first treated the patient for what he thought was a mild attack of gall-bladder trouble. The appendix had been removed ten years ago. On February 4, 1925, he slipped on ice, following which the patient had pain in the left groin and left side of abdomen. There was no sign of any hernia. Bowels were moved by oil.

Examination.—There was a mass in the upper portion of the abdomen a little to the left of the median line. The mass was slightly tender to touch, apparently smooth in outline and seemingly fairly well fixed. There was no history of any urinary disturbance. The mass felt like an enlarged kidney, and the diagnosis hinged between that of an enlarged, possibly cystic kidney, cyst or tumor of the spleen or tumor of mesentery or omentum.

X-ray taken by Doctor Pancoast at the University Hospital showed that the mass did not coincide with the line of the kidney and was, therefore, intra-abdominal.

February 27, 1925, the patient was taken to the Chestnut Hill Hospital. Following a hypodermic injection of morphine and atropine, gas anæsthesia was administered. The incision made was about four inches in length through the left rectus muscle. The left kidney was found in good position and normal in outline. The spleen was of normal size and shape. To the left of the median line, a large mass was felt consisting of a mass of intestines tightly bound together by adhesions. The intestines and other structures of the peritoneal cavity were packed away with gauze-pads; the intestines were separated and the mass itself was found to be one situated between the layers of mesentery of the upper portion of the jejunum. The incision was made through one layer of the mesentery immediately over the mass and the tumor shelled out from its bed from between the layers of the mesentery. The blood supply of the jejunum was preserved, the wound in the mesentery sutured, and the abdominal wall closed.

Post-operative convalescence was uneventful, and the patient discharged cured, March 9, 1925.

The mass removed proved to be a cyst about the size of an ordinary grape fruit. When opened, it was found to be filled with a thick, sebaceous material. Diagnosis from pathological laboratory—sebaceous cyst.

CONCLUSIONS

The specimen from Case I is undoubtedly an enterogenous cyst as is verified from the microscopical picture of its wall. The fluid present in the sac was bloody. Unfortunately, the chemical analysis was not made. It may have been blood, serum, lymph or chyle. Nevertheless, conclusions based upon the character of the cyst contents can hardly be considered final, for as Dowd has suggested, the fluid that collects in a preformed cyst is probably

a mere matter of chance, whether lymph, chyle, or blood from a ruptured mural vessel.

The symptoms here present are typical, associated with the symptoms of intestinal obstruction, a very common complication. The diagnosis of a cyst was made as well as obstruction of the bowel. Omental cyst, the symptoms of which are almost the same as those of mesenteric cyst, was considered but the diagnosis of mesenteric cyst was not made previous to operation. Had we made the diagnosis instead of omental cyst or ovarian cyst, we would have been the first to have had made a correct one previous to operation or autopsy. Fortunately, our cyst was one that could be enucleated. Enucleation is the most satisfactory treatment when it can be done. This patient had an uneventful recovery and when seen several days ago, she was in the best of health and has had no abdominal disturbance since her operation.

The *second case* (Dr. Charles F. Mitchell's patient) is interesting because the contents of the cyst was a sebaceous-like material and, therefore, Doctor Mitchell considered it a dermoid cyst of the mesentery. Unfortunately, there was no hair or teeth in this sebaceous-like material and the laboratory did not report on the microscopic findings of the cyst contents or wall.

We cannot, therefore, prove that this specimen is a dermoid cyst of the mesentery. If we could, this case would be the first case reported as a dermoid cyst of the mesentery in a male. This would disprove the theory, mentioned by Dowd and many other authors, in speaking of dermoid cysts, that they always are due to an error in development in the ovary or some one of the epithelial structures. Higgins and Lloyd (1924) also state that no retroperitoneal or mesenteric dermoids have been reported in the male though they have occurred in the testis which is originally a retroperitoneal organ. This has been held as evidence that an ovary is responsible for the true dermoid when it occurs in the mesentery.

This specimen might be the remains of a tuberculous lymph-node or a degenerated hæmatoma or lipoma. A tuberculous abscess in the mesentery may present all the features of a true cyst and in childhood is the most common type of mesenteric cyst to be exposed by operation. Both Haworth [25] and Gould (*loc. cit.*) have reported such cases.

Because of the inflammatory nature of the cyst, it was adherent to the neighboring bowel and thereby lessened the mobility of the cyst. The bowels were constipated but there was no intestinal obstruction.

The symptoms here present are not as typical and do not warrant the correct diagnosis as in our first case.

This cyst was also enucleated and the patient had an uneventful recovery and has remained well.

I am greatly indebted to Doctor Mitchell for allowing me to report this case.

The most interesting part of the discussion of these cases is their origin and we believe with Higgins and Lloyd that the classification depends upon definitely defining first of all, the "true mesenteric cyst" as "Those which

occur in or near the mesentery and which are not malignant, dermoid, or parasitic, and do not arise in any normally placed retro-peritoneal organ."

Such cysts can then be classified as (a) Cysts of embryonic origin arising from mesodermal remnants incarcerated behind the developing peritoneum and subsequently migrating forward between its layers; (b) Cysts of intestinal origin—I. arising in most cases as diverticula from the bowel during development and II. possibly derived sometimes from persistent portions of the vitelline duct.

In this, one of the most recent classifications, our first specimen a "true mesenteric cyst," will be classified under cysts of intestinal origin. We cannot determine definitely whether arising as a diverticulum from the bowel during development or derived from persistent portions of the vitelline duct.

Our second specimen is not a true mesenteric cyst. We can only say that it is a sac containing a sebaceous-like material in the mesentery of the jejunum of a male patient. If it is not a dermoid, it is possibly a tuberculous abscess, degenerated lymph-node, hæmatoma or lipoma.

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TUMORS OF TENDON SHEATHS

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Tumors of tendons and of tendon sheaths are very rare. This is the reason why no standard division or classification of them has been set up as yet, thus we find no chapters in standard books on pathological anatomy and surgery, which would specially deal with these diseases, excepting some short references.

Recently we had in our Clinic occasion to observe four cases of neoplasms of tendon sheaths. Besides which there was one case observed and given up to us in the Surgical Department of the General Hospital. I am indebted to Professor Ostrowski for the privilege of reporting it.

Case I.—M. O., female, aged twenty-four, complained of a small swelling in her right thumb for one year. The swelling grew slowly, giving no pain. It hindered the flexion of the thumb and the grasping of things.

Examination.—On the palmar side of the right thumb a hard well-defined uneven tumor was found. It was a little larger than a hen's egg, not painful and free of the phalanges and skin which was normal and movable.

The movement of the finger was very limited, the flexion of the joint especially being practically impossible, while the flexion of the phalango-metacarpal articulation was possible only within the extent of 15° to 20°. The tumor appeared to originate in the flexor tendon of the thumb.

Operation (Doctor Janik).—The tumor was exposed under local analgesia and easily separated from the surrounding tissues. Approaching to the base of the tumor it was seen that it was attached to the sheath of the flexor of the thumb. The tumor was removed together with a part of the sheath, which was closed with a single suture.

Macroscopic Examination.—The surface of the tumor removed was broken up into many lobulations. On section some brighter stripes of connective tissue were seen, running from the capsule toward the centre and separating the remaining mass of the cartilage into lobules. The parts lying nearer to the tendon sheath seemed to be more opaque, hard and resistant to cutting. The specimen measured 4 x 3 x 3 cm.

Microscopic Examination.—Broad stripes of connective tissue with a small number of nuclei, surrounding lobules of hyalin cartilage. The opaque area was caused by the calcification of the external part of neoplasm (Fig. 1).

Microscopic Diagnosis.—Chondroma with calcification.

Case II.—O. W., male, aged twenty-five, stated that a tumor had been growing for three years on the plantar side of the second toe of the right foot. The tumor gradually increased, without causing any discomfort.

During the last two months the tumor grew rapidly and became painful. The pain increased during walking on account of boot-pressure.

Physical Examination.—On the plantar side of the second toe of the right foot a growth was to be seen, as large as a hen's egg, hard and uneven, which pressed the toe up. The flexion was considerably limited, but the extension of the joints of the toe was not hindered.

The tumor seemed to be connected with the toe-phalanges.

Röntgen-ray examination showed a circular shadow of the tumor, against which the outline of the first and second phalanges of the toe were visible, the shadow being more opaque than that of the soft tissue, and less opaque than that of the neighboring bones. In the middle of this homogeneous shadow, an island of a darker area in the shape of a butterfly was visible, irregularly and sharply outlined. The limits of the bones were normal, a distinct line of demarcation between the spongiosa and compacta, however, was missing. The shadow of the second toe phalanges was more distinct than that of the neighboring bones, because the shadow of the phalanges and that of the neoplasm was intensified. Thus, it did not appear to be in any connection with the phalanges.

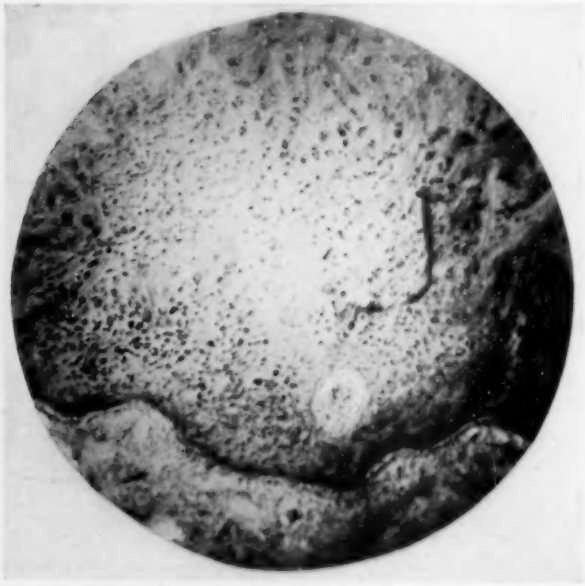

FIG. 1.—Case I. Chondroma of tendon sheath showing calcification.

Operation (Doctor Ratajski).—Under local anæsthesia a longitudinal incision was made, exposing the tumor.

During the operation the difficulty of removing the tumor appeared so great that it was impossible to remove it without exarticulation at the metacarpophalangeal joint.

Macroscopic Examination.—The toe with tumor removed was divided into two halves. The neoplasm was closely attached to the sheath of the flexor and was movable in relation to the phalanges.

The surface of the phalanges was even and distinctly separated from the mass of the neoplasm.

The tumor was well encapsulated, of a cartilagenous consistency, uneven and lobulated. It originated from the external surface of the flexor sheath, being organically connected with it. It surrounded the sheath and the tendon which pierced the tumor running within the canal formed by its sheath.

Microscopic Examination.—Revealed the tumor as a chondroma. The connective tissue stroma surrounded the islets of the hyaline cartilage. The opaque area shown in the skiagram was due to calcification of a part of chondroma.

An examination of the borders of the neoplasm and of the tendon sheath showed close organic connection between the neoplasm and the sheath; the edges of the sheath were uneven and ragged, and the tissue of neoplasm penetrated the sheath in the shape of islands. Thus, there were no distinct and sharp limits between the sheath and neoplasm.

Microscopic Diagnosis.—Chondroma with calcification.

CASE III.—J. C., workman, forty-three years of age, complained of a growth over the dorsal surface of the right forearm. Fifteen years ago he was struck in his forearm with a heavy pole. Three months later he noticed a small swelling in the same place which increased, but gave him no pain. During the past twelve months it became painful, and grew rapidly larger. The movement of the wrist was painful.

Physical Examination.—On the volar surface of the right forearm there was a tumor between the carpal joint and the upper half of the forearm, but not sharply out-

lined, in its distal end very painful. It was hard and free of the skin which was normal, and could be moved a little laterally.

The lymph-nodes in the axilla were not enlarged.

Operation (Professor Schramm).—The tumor was exposed by a longitudinal incision and separated from the surrounding tissue. After lifting the neoplasm it was found to be lying on the muscle layer of the forearm, attached to the sheath of the tendon of the flexor carpi radialis. In one place it had grown together with the tendon, and it was difficult to separate the mass from the tendon. Thus, it had to be removed with a part of the tendon.

The patient recovered without any complications.

Macroscopic Examination.—The specimen removed consisted of a large circumscribed, lobulated and encapsulated mass, which measured 18 x 12 x 11 cm. On its surface a number of hard or soft translucid tubercles containing a mucous fluid were seen.

On the section the mass appeared to be composed of a gray tissue which was darker than the tissue of the capsule, and was of various consistency, *viz.* on the periphery it consisted of a whitish, dense fibrous tissue, while the deeper parts were of a more soft consistency and looked brownish.

There were scattered areas of a more opaque appearance, very hard and difficult to cut. The largest of them nearly of the size of a pigeon's egg. There were also empty spaces, *viz.*, dissected cysts.

FIG. 2.—Case II. Skiagram showed no evidence of connection of neoplasm with the phalanges.

Microscopic Examination.—Sections taken from this growth show a neoplasm composed of rather mixed tissue. Chiefly it is composed of numerous spindle-shaped cells running in stripes in different directions, with a small quantity of intercellular substance.

In its whole this part of tissue corresponds to a typical picture of fusocellular sarcoma.

Apart from the fact that that tissue formed the main part of the neoplasm, it formed also nests and stripes amid the other substance, *viz.*, cartilage of a homogeneous hyaline appearance. This cartilage had cells, irregularly arranged and of different sizes. Amidst that cartilagenous tissue there were areas of calcification, irregularly distributed. The trabeculæ of cartilage in these places were calcified, and the periphery had a true bone picture. In some other places the islets of cartilage showed at their peripheries attenuation of the tissue, assuming gradually a mucous character. Somewhat further there were areas of what may be considered as myxoma.

Between all these tissues there were spaces filled with connective tissue running in irregular stripes. It was of a considerable density, and showed hyaline degeneration.

Thus, the whole was a mixed neoplasm composed of tissues of fusocell, sarcoma, fibroma, myxoma, chondroma, and osteoma.

A more exact revision of the section showed that the cartilagenous tissue constituted

in this neoplasm the material from which two other tissues, *viz.*, the myxomatous and osteoid ones took their origin.

It was endeavored to ascertain under the microscope the relation of the neoplasm to the tendon, because during the operation it was found that the tumor was connected not only with the sheath, but also the tendon itself. It was therefore important to decide, if the neoplasm originated from the tendon or from the sheath. It was seen in many sections that the tendon tissue is separated distinctly from that of the neoplasm which stood off from the tendon, which suggested that no organic junction existed between the tendon and the neoplasm.

Microscopic Diagnosis.—Fibrochondromyxoosteosarcoma.

CASE IV.—Z. E., a married woman, aged forty, was admitted to the Surgical Clinic complaining of a growth over the volar surface of the right forearm. It appeared five years ago, and has been increasing in size, gradually but slowly, without causing any pain.

FIG. 3.—Case II. Longitudinal section of neoplasm. *a*. Distinct limit between the phalanges and neoplasm. *b*. The tendon sheath, of the external surface of which the neoplasm came out. *c*. Flexor of the toe. *d*. The canal within the neoplasm in which the tendon runs.

During the last year the woman began to feel pain, and the tumor increased greatly, and hindered her work.

The patient did not remember having injured her forearm.

Physical Examination.—On the volar region of the right forearm, above the carpal joint, there was a swelling about the size of a fist; it was sharply limited and freely movable laterally, less, however, in the axis of the extremity. It was elastic, and the skin around it was normal. The limits of the tumor were sharply outlined while straining the flexors.

Between the skin and the tumor one could feel the tendon of m. palmaris longus.

The movement in the carpal joint was normal.

Operation (*Doctor Janik*).—The tumor was exposed in local anæsthesia. It was attached to the sheath of the flexor digitorum sublimis and surrounded the tendon for the space of 5 cm. The tendon was separated from the neoplasm which was excised together with a part of the sheath (Fig. 7,a).

Macroscopic Examination.—The mass removed measured 6½ x 3½ x 1 cm. and had the shape of an egg. Its surface was even and grayish. On one of the surfaces a canal was seen, covered with the tendon-sheath which had been excised together with the mass. The canal corresponded to the course of the tendon.

The tumor was hard and whitish in the periphery (on the section), soft and reddish in the centre. The tissue had a spongy appearance and blood could be squeezed out of it.

The capsule of the neoplasm was thick and hard.

Microscopic Examination.—The sections taken from the periphery of the neoplasm showed a fibrous connective tissue with scanty blood-vessels and cells. The nuclei of the cells were spindle-shaped and the fibrillæ ran in different directions.

In some places accumulation of cells could be noted, however, without any signs of malignant degeneration.

The capsule was thick, and showed hyaline degeneration.

On the sections taken across the middle of the tumor, numerous large and small spaces filled with blood were noticed, encroaching into the fibrous tissue. The red cells of the above-mentioned spaces preserved their unchanged appearance. There were no deposits of blood pigment. The walls of these spaces were covered with endothelium, and were sharply limited from the surrounding tissue. There was no evidence whatever

of any formation of new tissue which would tend to organize these spaces. This part of the tumor had an angiomatous appearance.

In the nearest neighborhood of these angiomatous spaces the fibrous tissue had become loose and resembled a myxomatous tissue. There were, however, no characteristic star-cells.

At the first glance one had an impression that this was an organized hæmatoma. But there were other signs which proved to the contrary: The clinical course (gradual growth), no connection with the surrounding tissue (the tumor was well encapsulated and even), macroscopic picture (on section taken immediately after the operation areas filled with fresh, not coagulated blood), finally the microscopic appearance (spaces bordered with their own walls contained unchanged blood, and absence of old pigment). All this proved that the tumor was a hæmangiofibroma.

FIG. 4.—Case II. Chondroma of tendon sheath showing calcification.

CASE V.—H. G., a female, aged thirty-two, noticed about eight years ago, a light swelling on her left forefinger which was painful and became larger in last six months. The patient stated that the swelling was originally on the palmar surface of the finger, and later deviated gradually to the radial side of the finger.

Physical Examination.—Disclosed a swelling about the size of a walnut, localized on the radial surface of the left forefinger, near the interphalangeal joint. It was tender on pressure, free of the skin, and movable laterally especially towards the palmar side.

It moved when the finger was flexed, but it did not hinder the normal movement of the finger.

Operation (*Doctor Gruca*).—The tumor was excised in local anæsthesia. It was attached by a long pedicle to the sheath of the flexor of the finger mentioned.

Microscopic Examination.—A section of the tumor showed a varied appearance. The mass of the neoplasm was composed chiefly of a dense fibrous connective tissue which at some places showed hyaline degeneration.

In some places, there was a large quantity of cells grouped in nests and cords. The nuclei of the cells were spindle-shaped.

The above-mentioned nests of cells finally flowed together in a homogeneous mass of sarcomatous tissue. In these places there was no further evidence of the density of the fibrous tissue.

The whole tumor appeared to be a fibroma with malignant degeneration in some places. The arrangement of cells resembled the early period of proliferation of an endothelioma. Dilated lymphatic spaces covered with a visible endothelium, however, were missing.

Microscopic Diagnosis.—Fibroma sarcomatodes.

Before we proceed to discuss tumors of tendon-sheaths, let us say a few words about the tumors of the tendons themselves.

They are very rare and some writers as Ombredanne, Buxton, believe they do not exist at all, and maintain that the cases described were not examined minutely enough, they should rather be considered as secondary growths, originating from the tendon sheaths, and only later encroaching on the tendons. Thus, in order to separate the tumor we must, during the operation, remove also a portion of the tendon. The microscopic examination shows then sharp limits between the neoplasm and the normal tendon tissue.

FIG. 5.—Case III. Fibrochondromyxosarcoma. *a*. The canal on the surface of the tumor in which the tendon ran.

The cases of tendon neoplasms known so far, are: fibromata, osteomata, and sarcomata (Schultz, Weir, Montprofit, Schwöbel, Lagrange, Hayem-Graux, Broca and others).

The neoplasms of tendon sheaths are more common than those of the tendons. The former, arising from the sheaths, and especially from the external surface do not limit the movement of the tendon, except when their size is considerable and when they surround the tendon on a larger area. It should be pointed out that neoplasms which originate in the internal part of the sheath lead to an early limitation of the movement of the tendon.

Malignant tumors having an inclination to infiltrate the neighborhood rapidly produce the same state.

The clinical diagnosis in such cases is not easy, because such growths can also imitate the neoplasms of muscles or of the connective subcutaneous tissue, or some inflammatory diseases. We will return to this question later.

The classification of the primary neoplasms of tendon sheaths is as follows:

I. Fibroma, grows slowly, rarely reaching large dimensions. It is generally hard. The clinical diagnosis is difficult, as the same course can be taken by giant-celled myeloma, and only the microscopical examination is decisive. So far, only thirteen cases of fibroma of tendon sheaths have been described (Nelaton, Buxton, Petzold, Sendler, etc.).

II. Lipoma is more frequent, and occurs in two forms: as lipoma arborescens and simplex. Clinically both can not be distinguished from one another. They may both grow within the sheath, surrounding the tendon, or outside it, connected with the sheath directly or by means of a pedicle (Strauss, Tichon, Sendler, Sprengel, Billroth, etc.).

III. Chondroma is very rare, of a small size and hard consistency. When

examined microscopically, it appears usually to be composed of islets of hyaline cartilage, lying between areas of fibrous tissue. In the centre of such islets places of calcification and even of ossification are often visible.

During the physical examination it is necessary to ascertain as far as possible, (a) whether the tumor does not arise from the bone in which case the X-ray examination shows the changes in the structure of the bone, the exact connection of neoplasms with the bone being found by palpation; (b) whether the tumor does not arise from the muscles, (as in cases described by Erichsen, Gibson, etc.), or from connective subcutaneous tissue; (c) whether it is not a ganglion which is usually of cartilagenous consistency, showing symptoms very similar to those of chondroma, especially in cases when chondroma lies in places characteristic of the ganglion.

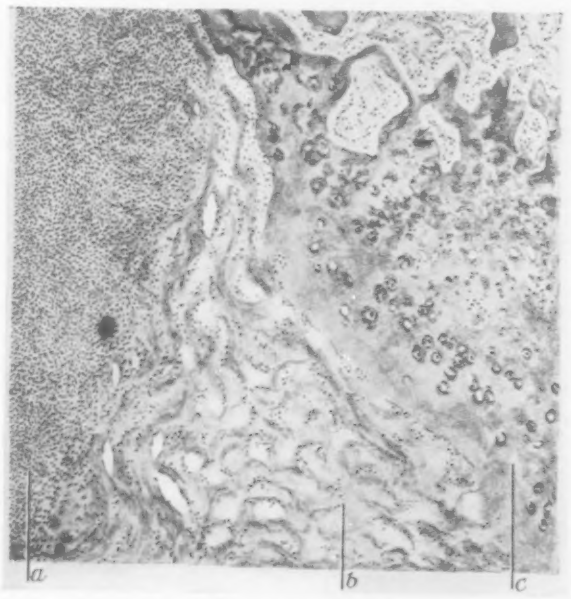

FIG. 6.—Case III. Fibrochondromyxoosteosarcoma. *a*. The sarcomatous tissue. *b*. Myxomatous tissue. *c*. Cartilagenous and osteoid tissue.

With the exception of four cases already mentioned in different papers (Billroth, Chauvain-Roux, Delbet, Pallailon), three new cases were reported recently:

1. BUXTON (1923). A professional violinist complained of pain and swelling in his left hand for two months. The swelling was soft, non-fluctuating. There was no evidence of an injury. At the operation an encapsulated mass was found with a pedicle attached to the tendon sheath of flexor, distal to the metacarpophalangeal joint of the left ring-finger. It measured 2½ x 1½ x 1½ cm.

Microscopic Diagnosis.—Chondroma simplex with areas of calcification.

2. BUXTON. No clinical history of the case. The diagnosis was: fibroma multiplex of tendon sheaths. Microscopic appearance corresponded to fibrochondroma.

3. BECK. (cited by Buxton). The tumor was attached to the tendon sheath of flexor of the forefinger.

Microscopic Diagnosis.—Chondroma with calcification.

To the above, our two cases should be added.

IV. Angioma, described by Pitzorno, occurs very rarely.

V. Sarcoma occurs as sarcoma globo-, fuso-, and giganto-cellulare. The commonest of sarcomas and generally of all tumors of tendon sheaths is:

A. Sarcoma giganto-cellulare (myeloma, xanthosarcoma). Its clinical picture and pathology is of great interest, to which a great many papers have been devoted. The first of these papers appeared in the second half of last

century. At that time the different forms of sarcoma were not distinguished, (Chassaignac, Czerny, Billroth, Spenzer, Wells, Paquet), Heurtaux's studies, however, solved the question. He gave the tumors the name of myelomata, as distinct from the sarcomata, based on the clinical course and microscopical picture, in which he found giant cells (1891). Seven years later the French pathologist Dor found in these tumors cells containing fat, another characteristic of myeloma. Further French works followed (Venoit, Mallerbe, Reverdin), ascertaining the presence of the brownish pigment of sanguineous origin, distributed in fine droplets intra- and extracellularly. The pigment corresponds to the Prussian blue reaction for hæmosiderin.

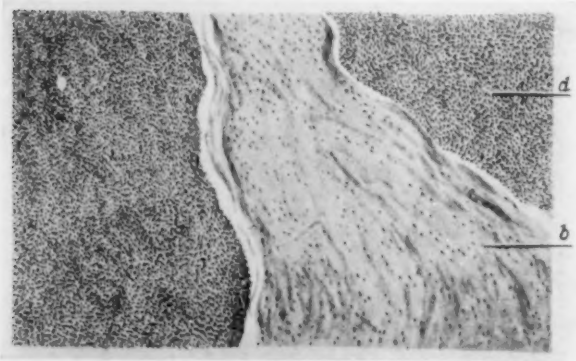

FIG. 7.—Case III. The tendon tissue limited sharply from the tissue of neoplasms.

Later the German authors began to take interest in the above kind of tumors (Rosenthal, Fleissig, Landois, Hartert, etc.) without accepting for them the French name *myeloma* which is still used in France, and giving them different names: xanthoma, xanthosarcoma, giant-celled sarcoma, etc.

Etiology.—The etiology of myeloma tumors is as generally in neoplasms unknown. Injury is quoted in the majority of cases as a provocating factor. The relation of trauma to the neoplasm is very differently explained (direct irritation of latent neoplasm cells, causing the inflammation and the formation of granulating tissue, on the ground of which an malignant growth develops, the producing of locus minoris resistentiæ according to the bacteriological theory.

The injury plays indeed an important part as shows the fact that the disease occurs on the upper extremities more frequently than on the lower ones (according to Rosenthal 54:17, according to Tourneaux, 66:27), more frequently on the palm and fingers than on the forearm (47:7, 50:6), lastly more frequent in men than in women (37:30, 55:38).

Pathology.—The size of the tumor depends on the localization, *viz*, the tumor is larger, the more proximally it lies. Therefore the average size of a tumor on the finger is that of a walnut, while on the palm and in the region of ankle-joint may be as large as a hen's egg (except the tumors on the hand which are subject to malignant transformation), and finally on the forearm it reaches to the size of a fist or still more. It is generally very limited and encapsulated, and only rarely does infiltrate the neighboring tissue. It may surround the tendon and nerves, having a longitudinal shape. The tumor is of yellow or gray color, in the last case with yellow areas in

proportion to the amount of lipoid. Further in many of them brownish areas are found as remnant of forearm hæmatomata (blood effusion). The consistency is elastic, rarely soft, showing false fluctuation (if any at all) causing numerous mistakes in diagnosis (the symptoms being similar to those of tenosynovitis).

Symptoms.—Generally after an injury the swelling appears and increases in size gradually but slowly, seldom causing limitation of movement of the extremity concerned, pain or other discomfort. No metastases are present, although some authors have mentioned them. These metastases however were due to true sarcomata. Sometimes, after the removing of the tumor a new swelling may grow in the same place, which must be considered as a false recurrence due to an incomplete removal of the neoplasm, especially in case of tumors of an infiltrating character. Thus, they may recur locally but they form no metastases.

FIG. 8.—Case IV. *a*. Tendon sheath.

Microscopic Pathology.—This is very characteristic. Some principal and characteristic components of such tumors must be distinguished, although not all often must be found in each case.

a. The growths are lobulated and well encapsulated. From the capsule stripes of connective tissue run toward the centre dividing the growth into many lobules. The connective tissue contains blood-vessels and shows a hyaline degeneration. From these stripes run bundles of fibrillæ surrounding nests of cells and finally single cells, gradually becoming smaller and smaller. The shape of the cells is various: small, large, irregular, polygonal, rounded, spindle-shaped, etc.

b. Giant cells containing a variable number of nuclei. Sometimes it is difficult to find these cells, and it is necessary then to examine all parts of the tumor. It should be added that often in tumors of the forearm the above cells cannot be found at all. Rosenthal states to have found giant cells only in one case of myeloma out of seven cases observed; it should be pointed out however that even in this case the neoplasm was, originally localized on the hand, and only secondarily passed on to the forearm.

c. Lipoid cells are large, vesicular, bright, similar to the xanthoma-cells and containing round or oval-shaped nuclei, often excentrically situated further plasma honeycomblike tissue (Weben-, Schaum-zellen) which is seen, whenever the specimen was subjected to the influence of liquids dissolving fats (alcohol, ether, xylol). On the other hand, if the specimen is congealed, the empty spaces are filled with crystals and fine droplets of fat. In the

polarimeter we perceive doubly refracted light, and in Sudan III reaction the lipoid cells become red-yellow. This fat-substance is a cholesterin ester of fat acid. On account of the increase of cholesterin in blood (hypercholesterolemia) crystals of cholesterin form local deposits in sheaths and tendons (Pinkus, Pick, Pringsheim). As consequence of irritation caused by the deposits of cholesterin results xanthosarcoma.

d. Numerous blood-vessels having thick walls affected by hyaline degeneration.

e. The presence of pigment deposits of sanguineous origin. The macroscopic examination shows dark brownish areas on the section and on the surface of the tumor. The microscopical findings of these places shows numerous crystals of hæmosiderin, both intracellularly and extracellularly. When exposed to the influence of potassium ferrocyanide it assumes a blue color.

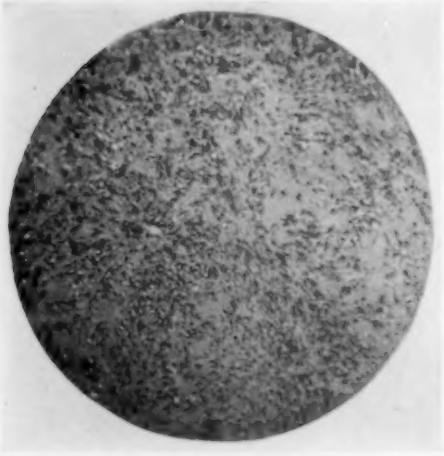

FIG. 9.—Case IV. The fibromatous area.

This pigment is the remnant of old extravasations of blood.

It must be added that myelomata are by some authors of recent years considered as granulomata of tendon sheaths of inflammatory origin (Fleissig, Beri, Broders, Buxton, etc.).

B. Sarcoma fusocellulare and glubocellulare. As a matter of fact it is a malignant neoplasm and differs from the giant-celled sarcoma in its clinical symptoms and histological picture in which the giant cells and lipoid cells are missing, besides Sudan III reaction is negative and the double refraction of light in the polarimeter is missing. The capsule may be present but the surface of neoplasm is generally without any lobulations. Most frequently it is of an infiltrating character.

Torneaux in 1913 reviewed the literature of 93 cases of sarcomata of tendon sheaths. Fifty-four of them were giant-celled sarcomata and 37 fuso- or globo-celled sarcomata.

To these statistics some new cases reported recently must be added. Most of them are xanthosarcomata:

1. HARTERT (1923).—A woman, aged fifty-eight, had a slowly developing tumor which grew to the size of a fist and sprang from the sheath of the tendon of m. tibialis posterior, grown together with the internal malleolus, the articular capsule and blood-vessels.

The excision of the tumor. Microscopic diagnosis: Xanthosarcoma.

2. HARTERT.—A man, aged about thirty-one, had a tumor as large as a fist, attached to the sheath of the m. tibialis anterior, grown together with the internal malleolus and articular capsule.

The growth was extirpated. Microscopic diagnosis: Xanthosarcoma.

3. HARTERT.—A woman, thirty-five years of age, had for sixteen years a tumor of the size of a fist over the os cuboideum.

Pirogot's amputation. Microscopic diagnosis: Xanthosarcoma.

4. HARTERT.—A man had a tumor originating from the tendon sheath of second finger. It was removed. Microscopic diagnosis: Xanthosarcoma.

5. HARTERT.—A neoplasm in connection with the tendon sheath of the flexor of the fifth finger of bean size.

The excision. Microscopic diagnosis: Xanthosarcoma.

6. FLEISSIG (1923).—A woman, thirty-eight years of age, had for two years a growth arising from the sheath of the flexor of the left forefinger. Clinical diagnosis: panaritium. Microscopic diagnosis: Granuloma.

7. FLEISSIG.—A woman, twenty-two years of age, during the past nine months a tumor appeared about the size of an American walnut, arising from the tendon sheath of the flexor of the right forefinger. Microscopic diagnosis: Granuloma.

8. FLEISSIG.—A woman had a swelling arising from the tendon sheath of thumb flexor. Excision. Microscopic diagnosis: Granuloma.

9. BUXTON (1921).—A young woman noticed a swelling, a little larger than a pea which was attached to the sheath of the long extensor of the right thumb. Removal. Microscopic diagnosis: Giant-celled myeloma.

10. BUXTON.—A woman, aged twenty-four, had a swelling of the size of a split pea attached to the tendon sheath of the right thumb flexor.

Excision. Microscopic diagnosis: Giant-celled myeloma.

11. KROGIUS (1922).—A woman, twenty-nine years of age, had for ten years, a fist-sized tumor arising from the tendon sheath of the m. tibialis anterior, grown together with the tendon of this muscle. Excision. Microscopic diagnosis: Xanthosarcoma.

12. KROGIUS.—A woman, aged fifty, noticed twenty-four years ago a small tumor which grew slowly and gradually reaching the size of a walnut. It was connected with the tendon sheath of the flexor carpi radialis. Excision. Microscopic diagnosis: Xanthosarcoma.

13. KROGIUS.—A man, aged forty-eight, complained of a walnut-sized growth which sprang from the sheath of the extensor tendon of the second finger. Excision. Microscopic diagnosis: Xanthosarcoma.

14. KROGIUS.—A woman, twenty-one years of age, had since the past three years a tumor of the size of a hen's egg. The tumor was connected with the tendon sheath of flexor hallucis longus. Excision. Microscopic diagnosis: Sarcoma fusocellulare.

After one year followed a recurrence which was removed. Exact microscopic examination showed xanthoma cells and doubly refraction of light. No evidence of giant cells.

Thus we obtain the number of 70 cases of myeloma of tendon sheaths reported so far in literature. It must be added however that this number may probably be increased, if the American literature be duly revised. We were only able to review the American journals of some last years.

Finally we must point out that some authors do not distinguish sarcomata giganto-cellulare from true sarcomata, and therefore some of them suggest radical operation including amputation of the extremity while they are quite benign in their clinical course, and may probably be that they are as mentioned above, inflammatory granulomata. Therefore, as such, they ought to form a separate group among tumors of tendon sheaths. We cannot, however, express our precise opinion, as we had not any such case in our observation.

The tendon sheaths are no rare places where mixed tumors occur. They may be composed of a benign neoplasm tissue such as fibrochondroma, or,

sometimes, they assume a malignant character, *e.g.*, chondrosarcoma, fibrochondrosarcoma, etc., and in our case fibrochondromyxoosteosarcoma. Among cases reviewed by Tourneaux, (Sonbeyran, Morestin, Broca, Mayer, Billroth, Buxton) mixed tumors are found quite often. Our cases belong to the most interesting ones.

Differential Diagnosis.—The clinical diagnosis of the above neoplasms is difficult, often possible only during or even after the operation on base of the microscopic examination.

Let us consider the commonest tumor of the tendon sheath, *viz.*, the sarcoma and try to distinguish successively the diseases that may be taken into account here:

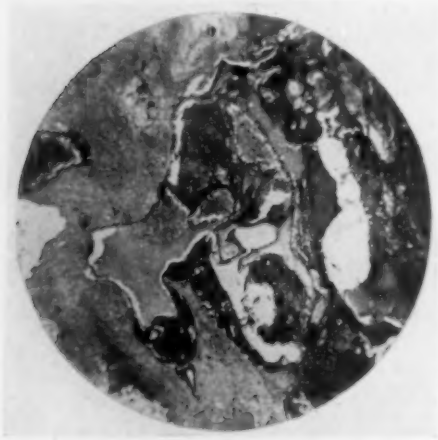

FIG. 10.—Case IV. The angiomatous area.

a. Sarcoma of tendon is rarer and characterized by early limitation of the movement of the tendon. If it has a smaller inclination to the infiltration into the surrounding tissue, it will be m o v a b l e if the tendon is brought into action.

The sarcoma of the tendon sheath, however, can give the same symptoms, if it affects the tendon secondarily, surrounding it from all sides. During the operation it is necessary to remove the sheath together with a part of the tendon. The microscopical examination shows then that the tendon tissue is unchanged and the limit between it and the neoplasm tissue is sharply outlined. On the other hand, if even a distinctly outlined sarcoma comes out of the tendon itself it may be only slightly movable, if the physiological movement of the tendon is small.

b. Benign tumors of tendons are very rare, and we can therefore leave them unconsidered.

c. Benign tumors of tendon sheaths: fibroma grows slowly, without attaining a large size, chondroma grows slowly, too, and has a hard consistency, lipoma can appear symmetrically or multiplex but not symmetrically, showing a false fluctuation. Sometimes it is lying under the fascia and then it grows along the tendon, giving a longitudinal swelling which can imitate chronic tenosynovitis.

d. Ganglion tendinosum appears generally on the dorsal region of the forearm (sarcoma reversally) and is small in size, spherical, and disappears after pressure.

e. Tenosynovitis tuberculosa granulosa is easy to distinguish from the sarcoma which has malignant symptoms but it is difficult to distinguish it from giant-celled myeloma, because the shape, localization, clinical course and symptoms can be similar in both diseases. In tenosynovitis the move-

ment can occur earlier, and the consistency of the swelling is softer. Other movements must be taken into consideration, in order to ascertain the diagnosis, *viz.*, the general physical symptoms, appearance and condition of patient, function findings, etc.

f. The tumors of other soft parts (muscles, fascia, etc.) too, can render

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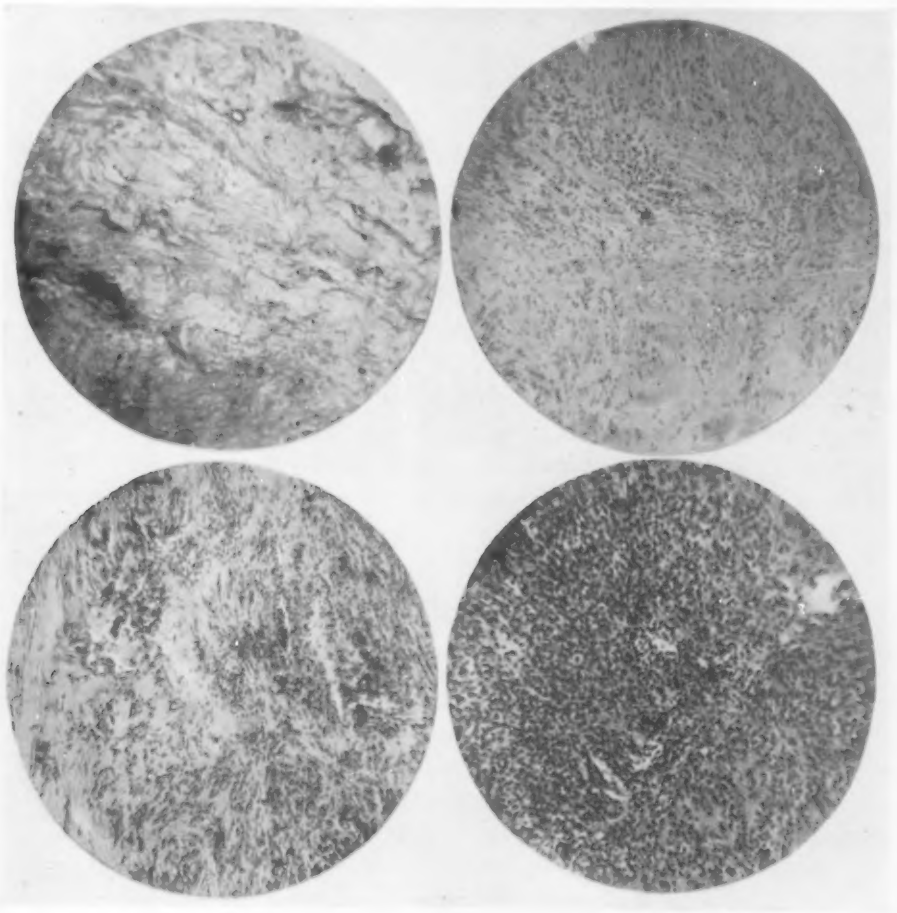

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FIG. 11.—Case IV. The loose fibromatous area.
FIG. 12.—Case V. Dense fibrous connective tissue. Hyaline degeneration.
FIG. 13.—Case V. The nests of spindle-shaped cells.
FIG. 14.—Case V. Homogeneous collection of cells.

the diagnosis difficult, as it imitates entirely the tumors originating from tendon sheaths.

As it may be seen from the above, it is very difficult, often even impossible to distinguish the sarcoma of tendon sheaths from other diseases which we have quoted.

Prognosis.—The prognosis of benign tumors is favorable. The excision of such tumors has no influence on the function of the extremity, even if they

have grown together with the tendons. The affected part of the tendon can easily be excised, and the remaining ends of the tendon can be stitched together, the tendon being prolonged in case of need.

The prognosis of giant-celled myeloma is good, because the tumor is easy to remove and does not form any metastases.

The worst prognosis is that of sarcoma.

The prognosis in regard to the function of an extremity is better in neoplasms of the fingers and hands than in the neoplasms of forearm where the growth (*e.g.*, myeloma) is usually larger and the excision consequently more difficult.

Treatment.—Depends mainly on the character of the neoplasm. In the majority of cases it is sufficient to apply the local excision of the tumor. The amputation and exarticulation of an extremity is made only in severe and malignant cases.

SUMMARY

1. Primary tumors of tendons are very rare. The commonest of them are the sarcomata.

2. Primary tumors of tendon sheaths are more frequent. The commonest among them are the giant-myelomata (granulomata).

3. The giant-celled myeloma seems to be caused by some injury or irritation. It is an inflammatory granuloma, and should therefore be excluded from the group of neoplasms, and included in that of inflammatory disease.

4. The following classification and terminology of the tumors of tendons and tendon sheaths should be adopted:

A. Neoplasms:

I. Neoplasms of tendons:

1. Benign neoplasms: fibroma, osteoma, chondroma.
2. Malignant neoplasms: sarcoma.

II. Neoplasms of tendon-sheaths:

1. Benign neoplasms: fibroma, lipoma, chondroma, angioma.
2. Malignant neoplasms: sarcoma.
3. Mixed neoplasms.

B. Inflammatory and other tumors: tendovaginitis tuberculosa, granuloma (the former myeloma), ganglion, etc.

5. The differential diagnosis between the tumors of tendon sheaths and inflammatory diseases especially tendovaginitis tuberculosa granulosa is difficult.

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METACARPAL CENTRAL GIANT-CELL TUMORS

By Emile Duskes, M.D.

of Baltimore, Md.

from the department of pathology, university of maryland, school of medicine

The purpose of this communication is to emphasize benign tumors of the metacarpal bones with particular reference to the giant-cell tumor and its differential diagnosis. Because of the rarity of giant-cell tumors in this location, it is felt that the following case is worthy of report.

Case Report.—Miss M. G., white, age seventeen years, was admitted to the service of Dr. F. S. Lynn at the University Hospital, September 17, 1926. The history was

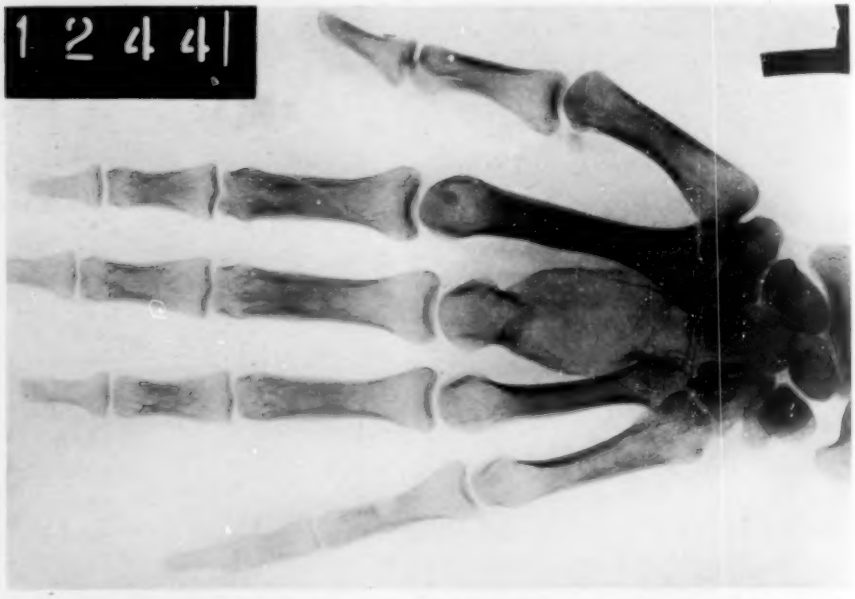

Fig. 1.—Röntgenogram, anteroposterior, showing involvement of third metacarpal bone, the expanded and thinned-out cortex, the trabeculations and the limitation to one bone.

essentially negative, with the exception that about one year previous to admission, she struck the back of her left hand; following this injury she noticed the development of a lump near the centre of the dorsal surface of the hand. This had gradually increased in size, but it was not painful.

Examination of the hand showed a non-inflammatory swelling over the third left metacarpal bone, extending almost to the head of the bone. This was approximately oval in shape, fairly firm and not tender. There was no disturbance in function.

The Röntgen examination showed (Fig. 1) a marked enlargement of the third metacarpal bone of the left hand. The shaft was expanded, the cortex was very thin but intact. The entire bone, with the exception of the head, was involved. There were fine trabeculations throughout. There was no destruction of the surrounding bones. No new bone formation was seen, nor were other lesions noted. Doctor Lynn performed the usual curettement operation.

The pathological material in this case consisted of a yellowish-red soft tissue intermingled with blood, having more or less the appearance of placental curettage. There was no bone or firm tissue present.

Microscopic sections (Fig. 2) revealed a mass consisting of many large multinucleated cells of the "Epulis type," held in a loosely arranged stroma composed of spindle-shaped cells. Numerous blood-filled capillaries were present.

Comment.—It is unnecessary to enter into controversial discussion as to the origin of giant-cell tumors except to call to mind the two main theories, viz.: (1) The neoplastic theory which holds that the lesion is a true tumor, having its origin in bone-marrow; (2) the non-neoplastic theory which holds that these tumors are the result of chronic inflammation or chronic irritation, such as a chronic hemorrhagic osteomyelitis (Barrie[1]), or a faulty repair phenomenon (Mallory[2]), or, as Ewing[3] believes, the end result of a bone cyst.

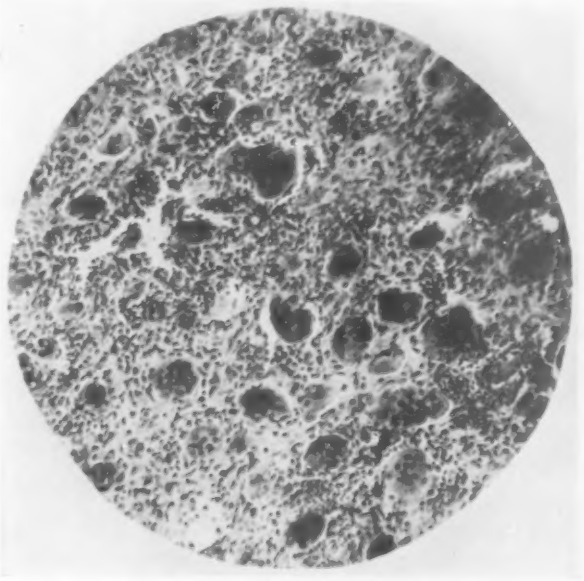

FIG. 2.—Section of tumor showing giant cells and stroma. Pathology No. 14727.

The first view depends essentially upon the origin of the giant-cell from the bone-marrow, that is, from the osteoclasts. To-day very few adhere to this theory. Apparently the giant-cells are derived from the endothelial cells of the blood-vessels or from monocytic infiltration from the blood. The giant-cells are of the true foreign body type such as are found in the epulis of the oral mucous membrane. Although giant-cells are encountered in the walls of bone cysts and particles of bone tissue are found in giant-cell tumors, nevertheless there are certain differences which might have an important bearing pointing to a difference in etiology, although as yet not correlated nor thoroughly understood.

In the case now detailed the history, röntgenogram and pathological findings permit no doubt as to the benignancy of the lesion. All the twenty-five points of diagnosis between benign and malignant bone tumors, as collected by Codman,[4] are present. In this respect the case is typical.

Central giant-cell tumors have the same general appearance in all the bones. The majority of the recorded cases have occurred after the second decade of life and the lesion has been found in the epiphyseal end of the bone. Contrasted with this is the bone cyst, which constitutes the largest number

of cases in the first two decades of life and is observed in the shaft of the bone, this Bloodgood [5] has shown.

In the metacarpus giant-cell tumors are very rare. In 1920, from his immense experience, Bloodgood describes only one case which was also in the third metacarpal bone of left hand. Here, diagnosis was obscured by a large surrounding œdema complicating picture and producing erroneous impression of a sarcoma. Apparently no other cases have been recorded in literature.

The most important clinical aid to the diagnosis is the age of the patient. Bone cysts are most prevalent before the age of twenty, and, as Phemister and Gordon [6] state, are essentially a disease of the growing period and rarely begin after adult life is reached. In adults, neoplasms predominate. Our patient was seventeen years of age, this favored a diagnosis of bone cyst. Although solitary cysts have been encountered in other bones of the body, usually, however, they are multiple.

The primary or original site in our case was not clarified by the röntgenogram. Both the epiphysis and part of the diaphysis were destroyed. Of true tumors the central chondromata are the most common, next in frequency appear the myxomata, both of which are more often noted in the phalanges rather than in the metacarpals. These usually occur in adults. These tumors frequently lack the appearance of trabeculations or the "stippling" of Rose and Carless,[7] which are due to the presence of scattered calcareous masses. Moreover, more of the epiphysis remains than is seen in the giant-cell tumor, where only a mere shell is left. When the differences are not distinct, the ultimate diagnosis will depend upon an exploratory operation.

Osteomata and periosteal lesions, as a rule, offer no difficulties. Malignancy manifests itself in the röntgenogram.

SUMMARY

A case of central giant-cell tumor of third metacarpal bone of left hand is reported in girl aged seventeen years. It is a rare situation for this condition. A brief discussion of its etiology and differential diagnosis is given.

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TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting Held February 7, 1927

The President, Dr. Charles F. Mitchell, in the Chair

BONE TRANSPLANTATION FOR SPONDYLOLISTHESIS

Dr. A. Bruce Gill presented three cases of spondylolisthesis which had been operated on by bone transplantation to fuse the three lower lumbar vertebræ with the sacrum.

Doctor Gill also presented a series of lantern sides illustrating: Osteochondritis of the hip (Legg's disease). Osgood-Schlatter's disease of the tubercle of the tibia. Koehler's disease of the tarsal scaphoid. Freiberg's disease of the head of the second metatarsal bone. Displacement of the epiphysis of the head of the femur during adolescence. Osteochondritis of the bodies of the vertebræ. Apophysitis of the heel.

OSTEOCHONDRITIS OF HIP

Dr. E. L. Eliason reported the history of a girl, aged eleven, who early in July, 1926, without apparent injury, began to limp but without pain. She continued to limp for six weeks, at which time an X-ray was made and reported negative. She continued to limp until December 23, when, following a slip on the ice, she was unable to rise due to disability in her left leg. On admission to the hospital, December 28, 1926, an X-ray revealed an epiphyseal separation at the upper end of the femur. Examination of her previous X-ray taken in August, disclosed the fact that a slight slipping of the epiphysis could be noted at that time. Fluoroscopic reduction was obtained and the limb placed in a Whitman abduction case, in which it was kept for five weeks. At this time it was removed and an X-ray taken which showed perfect reduction but also a rarefaction of the upper end of the diaphyseal fragment. This patient ran a persistent fever of from 99 to 99.2 or 99.3 during her stay in bed. Her leucocytes were between 10,000 and 11,000. Diagnosis: Osteochondritis with complete separation of the epiphysis. Patient is still in hospital.

Doctor Eliason gave the history of a second child, a boy, aged thirteen, who was well until a month ago, when he was struck on the left hip by himself with a hammer while doing some nailing. Following this he had some pain but was able to walk without limping. A few days later he began to limp and continued to do so up until about two weeks before his present accident, which occurred October 10, 1926. On this date, while walking along on the level ground, the patient's left leg rotated itself externally and he fell to the ground backwards. He was picked up and helped home, being unable to stand on this leg. He was admitted to the hospital eight days after his accident, at which time X-ray revealed an epiphyseal separation at the upper end of the femur. Reduction was accomplished under the fluoroscope and the limb dressed in a Whitman case. Throughout the patient's stay in the hospital he ran a slight temperature—average 99. A leucocyte count was

not made. At the end of seven weeks the case was removed and an X-ray showed a perfect reduction and union, there being, however, some rarefaction and absorption on the upper end of the diaphysis. The radiologist states that at this time he cannot be sure whether this rarefaction is due to the injury and disuse or some preëxisting disease. Diagnosis: Osteochondritis with complete separation of the epiphysis.

Patient has completely recovered but is still under observation.

Dr. W. G. Elmer said that he had at present a child of fourteen years, who fell while roller skating last September. She was treated in the general surgical service of one of our large hospitals for an intracapsular fracture of the hip, by means of an abduction plaster case from the ankle to the waist. The child still limps and has some pain when she walks without a crutch. The X-ray shows no union and the head of the femur is pushed down on the neck. There is shortening of approximately one inch. Intracapsular fracture of the hip is very unusual in a child. If the bone had been normal there should have been solid union in five weeks if the fragments had been in good position and the X-ray taken at the time the case was applied showed that they were in good position. There was evidently some fault in the texture of the bone and this case should be classed as osteochondritis deformans juvenilis or Legg's disease. The speaker does not favor bone pegging in these cases as the bone is of poor quality to start with. Abduction in plaster and protection from weight-bearing for six months is his method of treatment.

Another patient, a boy of seventeen years, was hurt in a foot-ball game, but continued in the game and continued playing during the remainder of the season, although he walked with a limp. He had been having chiropractic treatments from the autumn of 1924 to the autumn of 1925. His physician then had an X-ray examination made and also an examination by a surgeon and the diagnosis then made was tuberculosis of the hip. When first seen by Doctor Elmer in January, 1926, there was no muscle spasm, the hip moving freely in all directions, but with range of motion somewhat limited, and there was one-half inch shortening. The epiphysis was separated from and pushed down on the neck of the femur. A diagnosis of Legg's or Perthe's disease was made. A good result was obtained in this case after treatment over one year.

POST-OPERATIVE STRICTURE OF THE COMMON BILE-DUCT

Dr. Edward J. Klopp said that accidental injury of the common bile-duct with the resulting biliary fistula or stenosis and the evolution of the methods devised for the correction of these sequels are well known to most surgeons of experience. Fistula and stenosis occasionally follow purposive operations upon the common duct when there has been no error in technic. Obstruction may be avoided by burying a catheter in the duct extending into the duodenum as recommended by Duval and Richard. Their method is comparatively simple and should receive serious thought when drainage of the common duct is desired in the absence of infection. The T or fishtail tube is used because it is practical and easily introduced. In many cases a large amount of bile leaks around the tube. It may do no harm in the majority of cases but we cannot deny that it has caused serious damage.

The use of the buried catheter in reconstructing the common bile-duct as suggested by McArthur has given him and others gratifying results. He

recommends leaving the catheter long so that the intestinal tug will cause it to be discharged through the bowel after the duct has been repaired and epithelialized, and before there has been bile deposit about the tube to again produce obstruction. Short tubes may remain for an indefinite period and act as a nidus for deposit of bile salts.

Various plastic operations have been performed on the ducts many of which met with success. Eliot wrote a splendid paper in 1918 reporting three of his own cases and abstracting many cases from the literature and personal communications. It gives one a comprehensive idea of the various methods employed in plastic surgery of the biliary apparatus. The more recent paper by Walters adds valuable information regarding this work.

FIG. 1.—Showing part of a No. 24 French Catheter which has been in the repaired common duct and the duodenum for ten months. The patient is practically free from symptoms.

Needless to state that most of the cases reported have been dealt with satisfactorily. It is regrettable that more failures have not been reported. The Van den Burgh test has been a great aid in selecting a comparatively safe time when one might undertake to correct a stricture of the common duct. In the absence of fistula and the increase of bile pigment in the blood, it has been suggested that a fistula be established and correction of the stricture be done at a second operation. These cases are not select operative risks; the operation is time-consuming on account of adhesions and generally the absence of the gall-bladder as a guide. The following case is reported because of several impressive facts:

1. The common duct was injured while removing a gall-bladder that was not badly diseased.

2. The use of the fishtail tube in the first reconstructive operation was followed by stricture within six months.

3. Introduction of the buried catheter through the papilla of Vater and sphincter of Oddi was accomplished with considerable difficulty at the second reconstructive operation, due to the large size catheter.

4. The patient has worn the catheter for approximately ten months with little discomfort. One is amazed at the tolerance of the duct and the duodenum. We think the catheter should be removed through the intestine, probably jejunum. The patient declines interference so long as he is comfortable. It is feared that there will be a deposit of bile and subsequent obstruction.

A man, aged thirty-six; referred to Doctor Gibbon's service, Jefferson Hospital, by Doctor Immerman of the Gastro-enterological Department, August 24, 1925. The gall-bladder and appendix were removed elsewhere on April 4, 1925, for symptoms referable to the stomach and intestines with pain radiating under his right shoulder and back. Two drains were inserted. Three days later one drain was removed which was followed by profuse drainage of bile. Three weeks after the operation re-suture of the wound was attempted. There was profuse drainage of bile until six weeks before admission to Jefferson.

On admission there was marked jaundice with all the usual phenomena. There was a large fluctuating mass bulging in the region of the old scar. This was opened by the resident who obtained 1000 c.c. of bile. The jaundice faded, bile drained freely through the fistulous opening and the direct Van den Burgh was negative three weeks later.

On September 18, 1925, under ether anæsthesia, we injected the fistulous tract with methylene blue and excised the old abdominal scar and fistula. An obstructing scar 1 cm. long in the mid-portion of the common duct was partially excised and a fishtail tube inserted in the usual manner. A Penrose drain was placed along the side of the tube. Bile immediately drained through the tube; on the eighth day there was free drainage external to the tube. On the fourteenth day the tube came out. He was discharged, wound healed, no jaundice, digestion good, bowels satisfactory, on October 29, 1925.

He was symptom-free until March 1, 1926, when jaundice reappeared with the associated symptoms. Wound remained closed; no swelling of abdomen. He returned to the hospital, March 8, 1926; was transferred to the Pennsylvania Hospital, March 21, 1926, where I was then active. After careful preparation he was again operated upon April 12, 1926, under ether anæsthesia. The scar in the duct was 2 cm. long extending to the duodenum. It was excised. After dilating the papilla and sphincter of Oddi a No. 10 soft rubber catheter passed into the duodenum. We were desirous to bury a large catheter, having failed previously to prevent stricture. The duodenum was opened and more dilating was done with suitable instruments. It seemed as if a No. 24 catheter, the size we decided to use, should pass. We were unable to grasp the tip of the catheter through the sphincter with a duct stone forceps. The No. 10 catheter was introduced through the distal portion of the duct into the duodenum. The eye-end of the larger catheter was sutured in the funnel-end of the smaller and by pulling on it through the artificial duodenal opening and pushing on the larger from above it was put in position with comparative ease. A suitable mandrin was not at hand. The funnel extended upward into the dilated portion of the duct. It was impossible to make a satisfactory anastomosis of the duct. The defect was covered with omental tissue.

About 10 cm. of the distal end of the catheter was cut off. It was thought that too much catheter of large calibre in the small intestine might be very uncomfortable. I now think that this was an error. The duodenal wound was closed. A Penrose drain was carried to the site of duct anastomosis.

Bile drained externally for three weeks. There has been no drainage since. The scar is satisfactory; there is no evidence of hernia.

Dr. John B. Deaver said that with the patient he agreed that it is better to continue to wear the tube. Doctor Deaver has had the tube remain as long as eighteen months, and then be passed. The tugging probably has little to do with this. One patient wore a T-tube for four years. The most satisfactory operation when feasible is anastomosis of the proximal end of the common duct to the duodenum. This is not a difficult operation and offers excellent results. However, it was not possible for Doctor Klopp to do this in this case. It sometimes requires two or three operations to secure a result in this type of case with always a chance of subsequent stricture.

PRIMARY ULCER OF THE JEJUNUM

Dr. I. S. Ravdin read a paper with the above title, for which see page 873.

ACUTE INTESTINAL OBSTRUCTION

Dr. J. Stewart Rodman reported three cases which had occurred during the past year in his service at the Bryn Mawr Hospital. In each case the cause of the obstruction was sufficiently unusual to warrant placing it on record.

Case I.—A woman, age fifty, was admitted to the hospital, November 28, 1925, with the chief complaint of "pain in abdomen and vomiting." About twelve hours before admission she was suddenly seized with severe pain in the lower abdomen followed by nausea and vomiting. The pain at first was generalized throughout lower half of abdomen, later to become more localized about umbilicus. The bowels had moved the day before. Several enemas before admission had failed to give relief. The patient had had a cholecystectomy and vaginal repair eight years ago. The past history was otherwise negative. When admitted she was in acute abdominal distress. Palpation of abdomen revealed a suggestion of a mass on the right side of abdomen, although as she is quite stout, it was impossible, to be sure of this. Vaginal examination was negative for pelvic pathology. A diagnosis of acute intestinal obstruction due to adhesions from laparotomy was made. Operation revealed a large mass filling the entire right lower quadrant across middle line due to an enormously distended bowel. A puncture was made which immediately allowed a large quantity of gas to escape. The collapsed bowel was then easily delivered and as this was done the bowel was seen to rotate completely, relieving the obstruction above and below. The portion of bowel involved was the lower part of the ascending colon and cæcum. The appendix was removed and the wound closed without drainage. The patient made an uneventful recovery, leaving the hospital three weeks later. This case was obviously one of torsion at two points, one in the ascending colon, another in the terminal ileum, completely isolating and obstructing the intervening loop of bowel. A cursory review of the literature for the past ten years has failed to reveal another case of torsion at two different points of the bowel isolating and distending a loop as in this case. Acute obstruction due to torsion at a single point is, as would be expected, a fairly common occurrence.

Case II.—A man, age sixty-eight, was admitted to the hospital, November 4, 1925, with chief complaint of "obstruction of the bowel." Six days before admission he had been suddenly seized with severe pain in the lower

left quadrant of abdomen and vomited. Morphia relieved the pain partially. On the fourth day after the onset of the illness the pain was suddenly and spontaneously relieved and the bowels moved. The pain returned the following day and enemas were ineffectual. No further vomiting occurred. The man had had a double inguinal hernia for the last twenty years for which he had worn a truss. On admission the temperature was 99.3, pulse 80, respiration 20. He was apparently in pain. The abdomen was moderately distended, resistant and somewhat tender on the left lower quadrant. No definite tumor mass was found in left inguinal canal, although the overlying tissues somewhat swollen and tender. There was a reducible hernia on the right side. Under local anæsthesia the left inguinal canal was opened. No hernia was found but a thickened and œdematous spermatic cord which traced to the internal ring disclosed a mass apparently adherent to the ring within the abdomen. The incision was enlarged upward, opening the abdomen, and a loop of small intestine found adherent to the parietal peritoneum. No attempt was made at that time to dislodge the mass, but a Paul's tube was inserted into a loop of bowel proximal to the mass. The patient made a relatively smooth recovery from the operation but two subsequent attempts to close the fecal fistula have been unsuccessful. Ileosigmoidostomy was performed nineteen days after the first operation and inversion of the fistula was made six weeks later. In spite of daily evacuations by rectum the fistula continued to drain.

Reduction of strangulated hernias *en masse* happens every now and then, but in the reported cases has always been the result of taxis. The unusual feature of this case was that no taxis was used but large and repeated doses of morphia given.

Case III.—A man, age fifty-five, was admitted to the Bryn Mawr Hospital, January 18, 1926, with the chief complaint of pain in the abdomen. On the previous day the patient had been seized with pain in the left lower quadrant and took paregoric for relief. The pain continued on the following day, gradually increasing in severity. Vomiting occurring once. The bowels have been more or less constipated for some time, but moved slightly twenty-four hours before admission, on the second day of the illness. The patient had been in good health save that one week prior to admission he was run over by a wagon, sustaining contusions of both legs. On examination the abdomen was slightly distended and tender in lower left quadrant and there was rigidity of the left rectus. Peristalsis was about normal. No masses were felt. Temperature 98.2, pulse 60, respiration 20. At operation, the evening of admission, the intestines were found to be filled but no free fluid was present. A small mass was felt within the abdomen adherent to parietal peritoneum over the sigmoid. On further exposure the mass proved to be sigmoid somewhat kinked and adherent to parietal peritoneum by an inflammatory mass in its wall. Gentle manipulation loosened the mass from the parietal peritoneum, upon which, the sigmoid resumed its normal position. As the mass was small and did not then encroach upon the lumen of the bowel, it was not disturbed. Convalescence was uneventful except for a surgical wound infection. W. J. Mayo (*Journal American Medical Association*, September 8, 1917), in 1907 reported with Adson and Griffin five cases, of diverticulitis of the sigmoid, the first in which the pathology was established during life—since has resected bowel for diverticulosis in 42 cases—in 36 sigmoid, one transverse colon, in one the hepatic flexure and cæcum, in one the rectosigmoid juncture and in two the rectum; all acquired symptoms suggestive of acute appendicitis on left side. Mayo recognizes four types. I. Self limiting Diverticulitis and Peridiverticulitis. II. Diverticulitis

and Peridiverticulitis with abscess resulting in Fistulæ. III. Obstruction (31 per cent. malignant disease coexists) Obstruction not quite complete therein differing from carcinoma. It is sometimes necessary to do colostomy or temporary ileostomy. IV. Carcinoma developing on a Diverticulum.

Of 42 cases operated up to time of report, 14 per cent. died as a result of operation.

J. T. Rogers (*Minnesota Medicine*, January, 1923) believes the surgical treatment in any given case must depend upon the severity of the symptoms, the condition of the patient, and the judgment of the operating surgeon. From his own experience and a careful review of many cases reported, he is convinced that simple drainage in most cases will be followed by cure. In three cases resection seemed necessary but drainage resulted in cure.

The incidence of diverticulitis of the large bowel is set forth by J. W. Larimore (*Journal Missouri State Medical Association*, April, 1925) in 4408 X-ray examinations he found 55 times (1.24 per cent.). In 21 cases there were isolated diverticula, 34 cases showed multiple diverticula. The sigmoid was the most frequently involved portion of bowel.

Dr. Walter G. Elmer recalled a patient who had complete obstruction for one week. A long median incision was made and instantly the large intestine protruded from the wound and became distended to the size of a child's balloon and seemed to be on the point of rupturing. It was opened to relieve the tension and closed at once. Apparently the transverse colon had been hanging down in the abdomen and a long loop had apparently twisted on itself. Reversal of the colon immediately relieved the obstruction. The operation was completed by colostomy and the patient made an uneventful recovery. The colostomy will be closed subsequently by a plastic operation.

MESENTERIC CYSTS

Dr. William B. Swartley read a paper with the above title, for which see page 886.

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY AND THE PHILADELPHIA ACADEMY OF SURGERY

Joint Meeting Held February 9, 1927

DR. WALTON MARTIN in the Chair

CIRRHOSIS OF LIVER; OMENTOPEXY; SPLENECTOMY

DR. ALLAN O. WHIPPLE presented a man, thirty-six years of age, who was admitted to the Presbyterian Hospital of New York, August 24, 1920, on account of copious hæmatemesis. His history was essentially negative. He had never had any pain or discomfort after meals. He had noted, that at times during the past year, his stools had been dark; had been subject to frequent nose bleeds. Two months ago when apparently in perfectly normal health, he experienced sharp pain referred to the middle of the abdomen which disappeared after a few minutes. During the following night, he began to vomit food mixed with blood, the vomiting recurred at frequent intervals for a period of some hours when it ceased. There was no pain. He remained in bed thereafter for a period of ten days when he felt as well as ever. Three days before admission he was awakened from a sound sleep by nausea and vomiting. The vomitus was chiefly dark blood; was about one-half pint in amount. Soon after he also passed a black stool. Following this, his hemorrhage ceased, leaving marked weakness. When he was admitted, his general physical examination was essentially negative save for anæmia; the abdominal examination revealed, in the left upper quadrant, a palpable mass extending from the midline down to the level of the umbilicus, not tender, smooth, firm, edge rounded, no notch made out. Red blood-cells, 3,300,000; hæmoglobin, 50 per cent.; white blood-cells, 2000; polymorphonuclears, 63 per cent. Small lymphocytes, 26 per cent.; large lymphocytes, 8 per cent.; transitionals, 3. Clotting time seven minutes; bleeding time normal. Red cells showed central pallor; platelets slightly diminished in number. The attacks of blood vomiting continued on account of which he was given three transfusions. At time of operation, the red blood count was 2,400,000; hæmoglobin, 60 per cent. Ascites developed with rapidity, demanding two tappings previous to operation.

At operation the peritoneum contained from three to five litres of straw-colored fluid; liver was cirrhotic; spleen was enlarged eight to nine times normal size; spleen was removed and a tongue of the omentum, 10 cm. long, was drawn out through the upper angle of the wound and fastened in the cleft formed by the split rectus fibres. Spleen, after removal, weighed 6 kilos; microscopical section showed almost complete disappearance of Malpighian bodies.

Convalescence was complicated by a right lower lobe pneumonia. Later he developed a thrombo-phlebitis of brachial vein. He gained markedly in weight; there was no re-accumulation of ascitic fluid. When discharged, red blood-cells were 4,500,000; hæmoglobin, 90 per cent. Now, over six years after operation, he remains well; has had no recurrence of ascites; no vomiting of blood; no gastro-intestinal disturbance of any sort; bowels regular; general health perfect. Red blood-cells, 5,000,000; hæmoglobin, 85 per cent.; white blood-cells, 7300; platelets, 350,000. Scar linear and firm; no hernia; no ascitic fluid; liver edge not palpable and on percussion, liver would seem to be somewhat smaller than normal.

Dr. T. Turner Thomas (of Philadelphia) said that in the Philadelphia General Hospital, in which the percentage of indigent alcoholics is very high, he had been able to find brief records of four cases in which he had resorted to omentopexy.

Doctor Thomas had undertaken the operation in each case with little expectation of benefit and as the result of his experience had not been able to develop any enthusiasm for it. The greatly lowered vital resistance of the patients, the usual advanced cardio-renal disease, absence of sufficient functioning of the liver and sometimes other grave complications, make the prospects for long-continued benefit doubtful. Except in one case which died thirty-two days after operation, the early results of the operation were distinctly encouraging, but death was not long delayed by it. The combination with splenectomy as done by Doctor Whipple may so change the results as to increase his confidence in the operation.

His first case was operated upon August 17, 1908. In this case, after the abdomen had been opened, the peritoneal surfaces were rubbed with gauze and the omentum was sewed to the anterior parietal peritoneum. The abdominal wound was closed without drainage, leaving a suprapubic opening for drainage to pelvis. The patient was discharged two months and two weeks after operation. During the subsequent year he was readmitted and discharged several times and finally died one year and twenty-three days after operation; still had ascites.

The second case was admitted to Philadelphia General Hospital, April 29, 1919. In February, 1919, without apparent cause, his abdomen began to swell. Getting no relief he came to Philadelphia General Hospital as above stated, about two months after beginning of swelling. From then to October 22, 1919, date of operation, he was tapped seventeen times at intervals of from four to twenty-three days, a total of fifty gallons being removed. Urine examined twelve times and showed a few hyaline and granular casts, a trace of albumin and occasional leucocytes.

Operation.—The adjacent surfaces of the diaphragm and anterior abdominal wall, liver and spleen were rubbed with gauze, the omentum at the upper part sewed to the anterior abdominal wall, and lower part in the abdominal incision. Rubber drainage tube to bottom of pelvis through suprapubic stab wound. Sutures removed November 12, and patient transferred to Medical Department, December 23, and after a short stay discharged. He was readmitted March 1, 1920, and transferred to the almshouse, where he died June 27, 1920, eight months after operation. Could obtain no record of cause of death or of condition preceding it.

The third case was admitted to Philadelphia General Hospital, November 22, 1923. She was a woman, thirty-four years old, and a chronic alcoholic; diagnosis: mitral regurgitation; hepatic cirrhosis, with marked ascites (tapped many times); chronic nephritis.

Under date of December 16, 1923, the following note was made: Repeated abdominal tappings have failed to check the transudation of fluid into the abdominal cavity. The portal obstruction must be extreme, for at times the patient passes blood by the rectum.

December 24, 1923, under spinal anæsthesia, a midline incision was made and a great quantity of straw-colored fluid evacuated. The liver was found to be atrophic and firm, but not nodular. The peritoneal surfaces of the liver

and spleen, stomach and intestines were rubbed with dry gauze, as well as the corresponding surfaces of the abdominal wall and diaphragm to induce the later development of inflammations and adhesions. The omentum was sutured to the peritoneum of the anterior abdominal wall as widely as possible. A suprapubic stab wound was made below the inferior margin of the operation incision and a rubber drainage tube inserted to the depth of Douglas' Pouch.

January 16, 1924, paracentesis yielded 4000 c.c. of greenish, turbid, frothy fluid.

January 23, 1924, abdomen tympanitic. Dulness in flanks. Peristalsis abnormally active in upper abdomen. Diminished in lower abdomen.

January 25, 1924, died, thirty-two days after operation. Autopsy showed fibrinous, purulent peritonitis and intestinal obstruction. Clinically the signs were of mechanical intestinal obstruction.

The fourth case was admitted to Philadelphia General Hospital, September 16, 1925, complaining of weakness and swelling of the abdomen and lower extremities of about three months' duration. He is fifty-six years old and has been a laborer working in and about breweries and saloons. He says he has been a heavy drinker all his life, but was perfectly well until about three months before admission when he first became aware of a gradual swelling of the abdomen and weakness without other symptoms. A physician tapped his abdomen, obtaining a "medium-sized bucketful." He was soon admitted to another hospital, but did not stay longer than a week, his abdomen being tapped there twice, each time about a bucketful being taken out. The swelling of the abdomen has been progressive during the four weeks preceding admission to the Philadelphia General Hospital, the legs and scrotum participating to a very marked degree. He says he was never ill before, never vomits except after excessive indulgence in alcohol. He has averaged a half pint of whiskey a day for the past ten years. He weighed 180 pounds three months ago, since when he lost twenty pounds. Is not now acutely ill but very uncomfortable from the abdominal swelling and œdema of the legs and scrotum and the dyspnœa. He has the characteristic alcoholic facies, but while his heart sounds are impaired in quality it is regular and has no murmurs and his lungs are in good condition. There are distended abdominal veins and ascites present but no gastro-intestinal symptoms except loss of appetite. Repeated examinations of his urine have shown not more than a faint trace of albumin and no casts. On September 18, seven litres of fluid were withdrawn from abdomen, but on September 25, only a small quantity probably because of the shortness of the canula, although on the following day the site of the tapping drained profusely. October 15, forty ounces were withdrawn and on the following day he was transferred to the Surgical Ward. Blood Wassermann, negative. Urine: specific gravity 1020, faint trace of albumin, no casts and no red blood-cells.

Operation.—October 30, 1925. A median incision is made about eight inches long from about two inches below the umbilicus upward. On opening the abdomen only a moderate quantity of fluid escapes, but more is soaked up and removed by gauze pads. The liver is contracted and hardened. The upper surface of the liver and the adjacent diaphragmatic surface is rubbed vigorously with gauze on both sides of the falciform ligament. In like manner the surfaces of the stomach, intestines, spleen and to a less degree the omentum, with the corresponding parietal peritoneum, are irritated. The omentum is then sutured to the anterior abdominal wall by three catgut sutures as far out as can be reached, the lower part of the omentum being

left free to be brought outside the peritoneum where it is sutured between the recti muscles, the margins of the divided linea alba being sutured together over it, after the peritoneal margins are closed around the protruding omentum. In the preceding cases a suprapubic drain was introduced into the bottom of the pelvis, but is omitted in this case because of the small quantity of fluid withdrawn by tapping and during the operation.

December 2, although the abdomen is moderately distended, free fluid cannot be demonstrated. There is now no œdema of the abdominal wall, scrotum or extremities, although he has been out of bed walking about or sitting down about eight and one-half hours. He says he has no shortness of breath, no feeling of weakness and experiences no difficulty in going up or down stairs. His face has lost the somewhat shiny redness and puffiness which was present before operation and is slightly wrinkled and hollow. He is very anxious to be discharged in order to go to work which he says he is as fully able to do as before his troubles began about three months before admission. He admits a strong desire for something to drink. He was discharged December 4, 1925. Six weeks later he was readmitted to Medical Ward on account of renewed swelling of abdomen and dyspnœa. Admits having been drinking steadily since discharge one month ago. The day after his admission eight quarts of fluid were withdrawn by trocar. He died January 27, 1926, twelve days after admission and almost three months after operation.

Dr. John Speese (of Philadelphia) said that the addition of an omentopexy in the treatment of Doctor Whipple's case might cause some confusion, that it had been used by him as a measure of further diverting blood from the liver in an advanced case of Banti's disease, whereas Doctor Thomas was alluding to an entirely different group of cases, *i.e.*, portal obstruction from cirrhosis of the liver. The improvement in the patient's condition must have been due to the splenectomy which is now regarded as the operation of choice and if these cases of splenic anæmia are operated upon early in their development, a cure should be obtained by removal of the spleen in a very high percentage. Unfortunately the majority of them come to the surgeon in a late stage, but even with adhesions between the spleen and the surrounding parts, with fibrotic changes in the liver and ascites, removal of the spleen is followed by pronounced improvement in many instances and the hemorrhages occasionally encountered, are almost immediately checked.

Dr. Willy Meyer (of New York) called attention to the eventual benefit to be derived from the use of superheated air treatment, when the omentum had been placed subcutaneously. Last winter he showed a patient before this Society, who had been operated on in 1911 for carcinoma of the rectum which was excised. He returned in 1924 with pronounced ascites. Tapping was done; but the liver was not palpable and not enlarged. X-rays seemed to indicate a possible malignancy of the stomach; and therefore exploratory laparotomy was done without finding any pathology in the stomach. The liver was seen to be rather reduced in size and in a condition of chronic inflammation; the patient was neither alcoholic nor syphilitic. As there was no secondary tumor, omentopexy was clearly indicated and carried out by placing a portion of the omentum in a pocket below the skin. Three weeks

later the patient had to be tapped once more, but subsequently made an uninterrupted recovery under the daily prolonged use of superheated air, which was continued at home for many months. It was observed that the ascites receded from week to week. This was two years ago and the man has remained perfectly well. Judging from this experience the simple method deserves to be tried in similar cases.

Dr. A. P. C. Ashhurst (of Philadelphia) said that he believed the splenectomy had more to do with effecting a cure in Doctor Whipple's case of Banti's disease than the omentopexy. Portal obstruction does not cause ascites, it causes gastro-intestinal hemorrhages; and many years ago Rolleston had pointed out that patients with uncomplicated cirrhosis of the liver never lived long enough to require more than one tapping. The patients who survive many tappings have something else than cirrhosis: they have a polyserositis, or they are cases of Banti's disease. It will be noted that the only case in Doctor Thomas' series in which omentopexy was of benefit had hemorrhage from the intestines before operation. The speaker thought one should restrict omentopexy to patients with hemorrhage and in cases of ascites merely take out the spleen, if Banti's disease seemed to be the cause, or attempt to relieve the abdominal serositis by gauze friction over the liver and spleen.

RUPTURED ANEURISM OF FEMORAL ARTERY

Dr. Allan O. Whipple presented a man, twenty years of age, who was admitted to the Presbyterian Hospital of New York, June 6, 1926, on account of painful swelling of the left thigh. Previous history negative, except for initial lesion of lues four years ago. Five months ago, he first noted a swelling of the left mid-thigh which has gradually increased in size until now it measures the size of an infant's head. Pain has steadily increased in it and has been extreme during past month. Swelling occupies lower two-thirds of left thigh. It is diffuse, fluctuant, hot and tender. There is no definite evidence of any expansile pulsation, although there was a slight bruit. Entire lower leg is œdematous; X-ray shows periosteal proliferation of lower third of femur probably of luetic origin. Red blood-cells, 2,300,000; hæmoglobin, 40 per cent.; white blood-cells, 22,800; polymorphonuclears, 88 per cent. Wassermann positive. A transfusion of 700 c.c. of blood was made, after which the red blood-cells rose to 2,800,000; hæmoglobin, 50 per cent.

Operation, under spinal anæsthesia, was begun by incision over Scarpa's triangle. This opened a cavity from which a sudden gush of old broken-down blood together with fresh blood took place. Left femoral vessels were ligated at once. This controlled the bleeding. On sponging the cavity, there was a sudden release of pus. Amputation was then performed below the trochanters. Patient stood operation well, but because of his anæmia, another transfusion was given after the operation. Cultures of pus showed pure growth of hæmolytic streptococcus. Dissection of the amputated extremity revealed a funnel-shaped enlargement of the femoral artery beginning 7 cm. below the level of the distal end of the femur. This was continuous with an aneurismal wall which had ruptured and become indistinguishable from the surrounding soft parts. Both ends of the funnel-shaped enlargement opened directly into the broken-down tissue of the soft parts. The middle third of the femur showed areas of thickened periosteum and in other areas eroded bone. The operation wound was Dakinized. Pulse and

temperature rapidly returned to normal. Pain immediately relieved; general condition improved rapidly from day to day. Further healing without complication.

Dr. Hubley R. Owen (of Philadelphia) said he had a case similar to Doctor Whipple's in his ward at the Philadelphia General Hospital some fourteen years ago. The patient was an elderly woman who on admission had a large inflammatory tender fluctuating mass in the upper third of the left thigh. As the patient was in considerable pain on her admission in the evening, the Resident Physician ordered the patient taken to the Women's Dressing Room and, after freezing the area with ethyl chloride, opened into the supposed abscess. The mass proved to be a dissected aneurism of the femoral artery. The tissues superimposed upon this aneurism were infected and considerable pus was evacuated before the aneurism was reached. The patient had a massive hemorrhage. The Resident Physician applied a tourniquet and when Doctor Owen was called it was necessary to do an immediate amputation. It was impossible to control all the bleeding about the aneurism. The patient never recovered from the shock of the operation and died a few hours later.

DIVERTICULUM OF THE BLADDER

Dr. Edwin Beer said that it is surprising that diverticulosis of the hollow organs has been recognized as a frequent occurrence only during the last twenty-five years. Diverticulum of the œsophagus and Meckel's diverticulum of the small intestine have been recognized for many years; on the other hand, diverticula of the intestine up to 1904 was scarcely appreciated as a clinical entity. In that year he was able to collect in his original paper on "Intestinal Diverticula" only eighteen cases from the whole literature of the preceding half-century. Nowadays, however, the condition is well known as a clinical entity, and hundreds—if not thousands—of cases of this disease have been recognized by the profession and the condition is regularly considered in the diagnosis of intestinal cases. Diverticula of the bladder have fared even worse than diverticula of the intestine, and it is only during the last fifteen years that numerous observers have been studying this condition and removing diverticula of the bladder by surgical procedures. Cystoscopy and cystography have opened this field to surgical therapy.

Doctor Beer then demonstrated a series of diverticula in lantern slides. Some of these diverticula of the bladder are enormous—one case having held as much as twenty-six ounces of residual urine. That they are probably congenital in a great many cases is evident from the fact that numerous cases have been discovered in children—one even in the first year of life. The presence of these diverticula leads to difficulty in emptying the bladder, and frequently a secondary dilatation of the ureter and hydronephrosis. Some of them are associated with obstructions at the neck of the bladder, and in prostatics or patients with contracture of the bladder neck, diverticula are liable to develop. The orifices are seen as a more or less dark hole cystoscopically, but the exact size of the pouch can only be determined by filling

it with an opaque fluid and taking X-ray pictures antero-posteriorly and laterally. Complications set in when these diverticula are infected and, occasionally stones form in these diverticula and have to be removed with the diverticulum. Occasionally, some of these stones project into the bladder as collar-button or dumb-bell stones filling the diverticulum and presenting as a mushroom growth within the bladder lumen. If the stone is left in the diverticulum, the stone extension into the bladder is regularly liable to reform so that the patient will get recurrent vesical calculi. In other cases, tumors form in the diverticulum, which present a group of cases that are most difficult to treat satisfactorily. With infection, peri-diverticulitis sets in and the pouch becomes firmly adherent to all the pelvic structures so that removal becomes a most difficult and arduous undertaking. In some cases the ureter empties into the diverticulum at some distance from the bladder, and various methods for caring for ureter were developed.

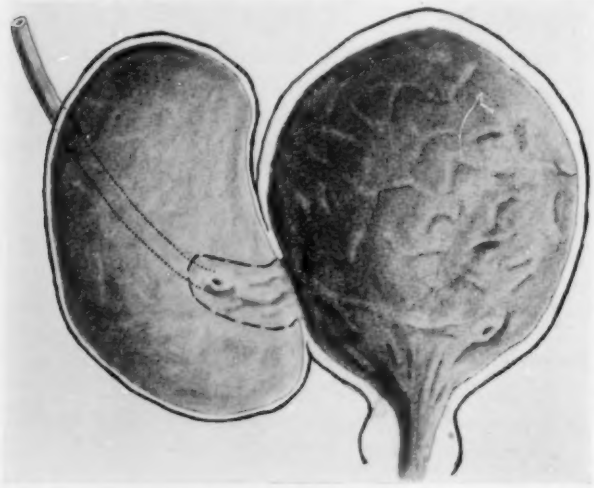

FIG. 1.—Diverticulum of bladder with ureter emptying into diverticulum. Triangular flap of diverticular wall outlined; the rest of diverticulum cut away.

The case about to be presented, shows a new method for caring for such a ureter which emptied into a diverticulum one and one-half inches from the bladder. The presence of one of these infected diverticula leads to very slow healing of the suprapubic wound, and occasionally in prostatectomies, one is forced to go in secondarily to get a closure of the suprapubic wound by the removal of the infected diverticulum. It is interesting to note that in the series of cases numbering well over two dozen that have come to operation in his experience, none of the diverticula have been seen in the female sex.

DOCTOR BEER then presented a man, sixty-six years old, who was admitted to Mt. Sinai Hospital, September 16, 1926, having been troubled with great urinary frequency for some time. At times overflow; at present, apparently, completely obstructed. Immediate suprapubic drainage operation was done, and after patient's blood chemistry had dropped, the second-stage removal of a small fibrous prostate was accomplished. No cystoscopy was done before operation. The patient's suprapubic wound, despite all attempts to encourage healing, failed to heal completely. It would regularly break down after being closed for a short time. His residual urine continued after operation around twelve ounces.

A cystogram was taken, and a large diverticulum was found on the right side of his bladder. Cystoscopy showed that this diverticulum was in the region of the right ureter orifice; its opening was about the size of a dime.

The left ureter secreted good blue, whereas no right ureter orifice could be seen. It was concluded from the cystoscopy that the right ureter emptied into the diverticulum.

January 7, 1927: A very adherent large diverticulum was excised, and it was found that the right ureter entered this diverticulum about one and one-half inches from the bladder. The ureter was left attached to a triangular flap, the rest of the diverticulum being excised; and the apex of the triangle

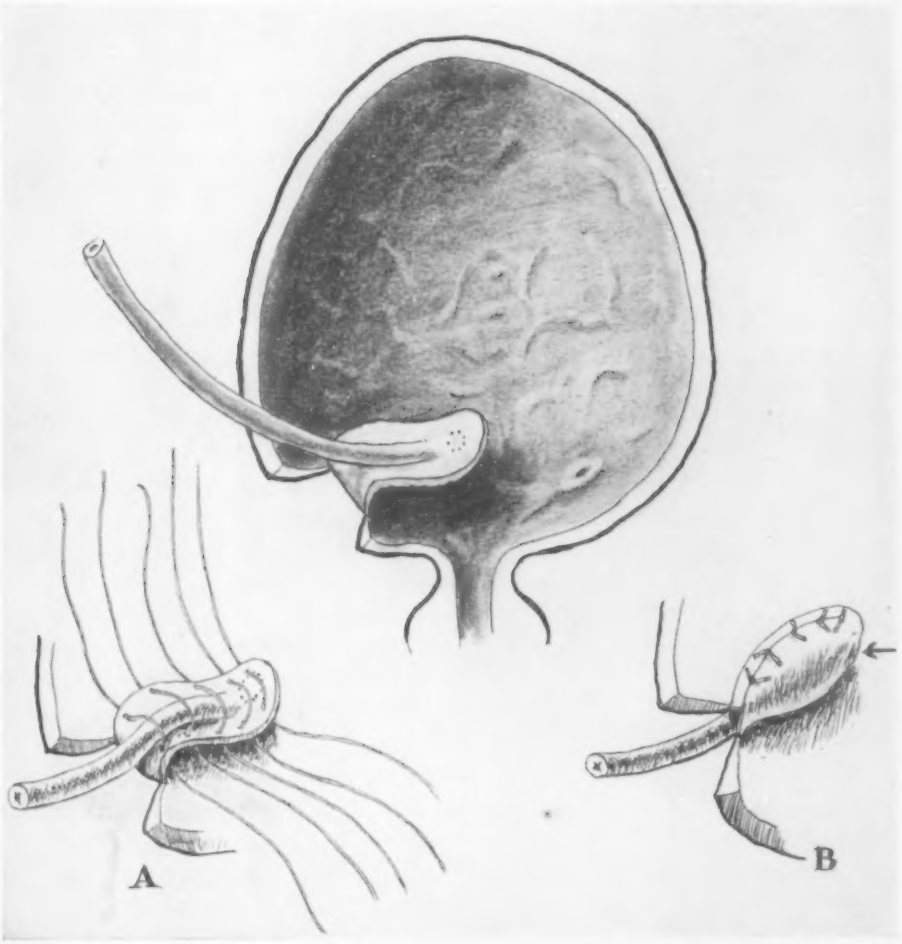

FIG. 2.—Illustrates steps by which right ureter was implanted into bladder and covered with diverticular wall.

was then drawn into the bladder and the mucous membrane of the diverticulum sewed over the ureter which now projected into the bladder. The orifice of the diverticulum was closed by several chromic gut infolding stitches applied to the outer wall of the bladder. The ureter catheter was passed up the right ureter at completion of operation to make sure that there was no stenosis caused by the plastic operation.

The patient's recovery has been uneventful, and with an indwelling catheter, his suprapubic wound has closed almost completely, or completely, so that patient is almost ready to be discharged from the hospital.

Dr. Leon Herman (of Philadelphia) said that in the surgical treatment of bladder diverticula excision of the sac is undoubtedly the method of choice, but the best means of its accomplishment differs in different cases. There are two types which present unusual difficulties, namely, those in which the ureter opens into the sac, and those in which the sac springs from the inferior wall of the bladder in close approximation to one or the other ureter. In the surgical treatment of the first type, such as that presented by Doctor Beer, it is necessary either to sever the ureter and transplant it to another part of the bladder, to ligate it, thus destroying the kidney on the involved side, or to dissect out a flap of the diverticular sac containing the ureteral opening, and, in some way, implant this into the bladder. In following the latter procedure, the method of Young has been used, in which part of the sac containing the ureteral opening is employed to close the defect in the bladder wall. This method has the inherent disadvantage of employing defective tissue, and, in one of our cases, the procedure was followed by almost immediate recurrence of the diverticulum necessitating re-operation. In Doctor Beer's method the flap is carried into the bladder cavity and the closure of the defect accomplished by approximating the edges of the healthy bladder wall, the one point of weakness being at the point of entrance of the ureter. This ingenious method of Doctor Beer's appears to be a very practical contribution to surgical practice in dealing with diverticula containing the ureteral orifice.

Doctor Beer added that in removing diverticula of the bladder, the ease of the dissection varied with the degree of peri-diverticulitis. Doctor Young suggested some years ago a method of aspirating diverticula with suction applied over the diverticular opening within the bladder. In small non-adherent pouches, which probably require very little treatment, this might be feasible, but in larger diverticula that cause symptoms usually associated with firm adhesions to the pelvic structures, this method could not be applied, and the suggestion to apply it in these cases was somewhat jocular. These latter diverticula are so firmly imbedded by peri-diverticular inflammation as a rule, that it requires the greatest muscular effort to pull and dissect the adherent sac from its intimate attachments to the pelvic connective tissue and fat.

PAPILLARY CARCINOMA OF KIDNEY PELVIS

Dr. Edwin Beer presented a man, forty years of age, whose chief complaint was an intermittent hæmaturia, with practically no pain until recently when he experienced some pain in left lumbar region. His painless hæmaturia began a year before admission (May, 1925), lasted three weeks and was profuse. Then there was a quiescent period. Six months before admission he had another attack of hæmaturia, and during the following months prior to admission, he had fifteen to twenty more attacks, bleeding usually for a few days at a time. Of late he has had some pain in the left lumbar region which did not run downward but radiated toward shoulder; pain gradually became more accentuated but seems to have no relation to hæmaturia.

He entered the hospital in May, 1926, after his last attack of hæmaturia had ceased. Physical examination showed no costo-vertebral tenderness and no abdominal palpatory findings. Cystoscopy showed a normal bladder and

normal ureters; no obstruction in either ureters and no retention in either pelves. It was impossible to induce bleeding in the left kidney pelvis, where it was thought the tumor was placed, by active to and fro manipulations of ureter catheter. The left kidney urea was 0.6 per cent., whereas the right was 2.0 per cent.; microscopic urinalysis showed an occasional red cell on the left, and many on the right. Several pyelograms were made, one of which showed very definitely incomplete filling of the left kidney pelvis and calices giving the appearance of fluffiness as if the pelvis was more or less filled with a spongy mass, making diffuse irregular densities.

FIG. 3.—Pyelogram of papilloma of kidney pelvis. To bring out the delicate contrast shadows in the pelvis which was filled with a spongy papilloma, the original film had to be reversed and then printed.

The patient returned in September, 1926, with the history that he had been bleeding for three weeks. Cystoscopy, while bleeding, showed blood came from left ureter, and none from right ureter. Moreover, at all levels in the left tract, bloody urine was obtained. At this examination, just in front of the left ureter meatus, a minute papilloma about the size of the head of an ordinary pin, was discovered which was probably an implant from the renal pelvic tumor. This was immediately destroyed with the high frequency current.

September 13, 1926: Nephro-ureterectomy was done with excision of wedge of bladder about left ureter meatus through a lumbar kidney incision in which the vascular pedicle was tied; combined with an extraperitoneal left rectus incision, exposing the lower ureter and bladder. On exposing the left kidney, it was found to be normal in appearance, normal in size, and the pelvis felt as if it were moderately distended with a soft spongy mass. No tumor could be felt. The parenchyma was absolutely normal in consistency. On removing the specimen the kidney was opened, and on incising the pelvis a papillomatous tumor, which filled the pelvis, mushroomed out through a small incision as if it had been under considerable tension.

Pathological diagnosis and microscopic report was "papilloma of kidney pelvis with early malignant changes."

TUMOR OF ACOUSTIC NERVE

DR. A. S. TAYLOR presented an adult male who was admitted to Bellevue Hospital, December 10, 1925. Since March, 1924, he had been deaf in his right ear. In December, 1924, he developed an unsteady gait. In November, 1925, hammering sounds developed in right ear with blurred vision; no headache, nausea or vomiting. Upon admission, examination revealed the following conditions: old healed Pott's disease, upper dorsal; bilateral papillœdema; marked nystagmus, coarse to left, fine to right; hypæsthesia of right cranial fifth nerve (including cornea); paresis of seventh nerve; sense of taste diminished on right side of tongue; right auditory nerve deafness; pedal ataxia on the right side; caloric test showed dead labyrinth on right side. Diagnosis was made of right cerebello-pontine angle tumor (acoustic nerve) for which an operation was done December 21, 1925. Ether anæsthesia. *First stage;* a curved, horse-shoe incision running from within one mastoid up over the occipital bone then down on the opposite side to the inner margin of mastoid. The occipital bone was entirely removed, including the posterior one-third of the foramen magnum; also the posterior portion of the Arch of the Atlas was removed. At this stage his general condition was such that operation had to be discontinued and the flap was temporarily sutured. *Second stage;* one week later—the dura was opened across both sides and then a fair-sized tumor of the right acoustic nerve was exposed.

The sheath was quite vascular and because of the generally poor condition of the patient it was not deemed wise to attempt complete enucleation of both the sheath and the tumor. Therefore, the sheath was split longitudinally and the tumor was completely enucleated from inside. When hæmostasis was complete the wound was closed, leaving the dura open for decompression.

His condition was very bad when he went off the table and that evening it was necessary to do a blood transfusion which very greatly improved his condition and after which he made a steady and satisfactory recovery.

In this case the tumor was approached by means of a curved incision passing across the head about 2 cm. above the superior curved line. At the outer ends this incision is turned downward so as to pass just within the posterior border of the mastoid on each side. The skin and galea are dissected downward until a place has been reached about .5 cm. below the superior curved line, when an incision is carried vertically through the attached muscles down to the occipital bone. In this way a good portion of muscle and fascia is left attached to the superior curved line for the purpose of the later closure. The muscles are then elevated from the occipital bone forward and downward until practically the entire occiput is exposed. From that point on the bone is removed, as usual, including the posterior one-third of the foramen magnum, and the posterior arch of the Atlas in such cases as it is indicated. With this incision, in the majority of heads and necks, it is possible to retract this flap sufficiently to get a perfectly adequate exposure for work anywhere in the posterior fossa.

This incision avoids the necessity of the median leg of the so-called cross-bow incision and, therefore, saves a great deal of time both in the making and in the later suturing; also saves a certain amount of bleeding. The only objection which has been raised to this flap has been that by carrying the outer ends of the incision downward back of the mastoid, there has sometimes been a greater likelihood of the development of a spinal fluid fistula. However, with proper attention to the closure of the lower ends of the incision, the wound can be perfectly protected from such leakage.

The point of chief interest from the standpoint of surgical technic lies

in the incision; *i.e.*, the horse-shoe flap without the cross-bow midline incision.

This particular case with the kyphos of the uppermost dorsal vertebræ would seem an unusually bad case for this exposure. Nevertheless, with this single flap turned down there was a perfectly good exposure with which to reach this angle tumor.

SPINAL CORD NEUROFIBROMA

Doctor Taylor presented a colored man, twenty-four years of age, who was admitted to Bellevue Hospital, January 17, 1927, with a history that six months previously he had developed: (a) Numbness of the entire left side of the body. (b) Two weeks later, weakness of the right leg. (c) Chronic constipation. (d) Two months after onset, vesical precipitancy. (e) Three months after onset, weakness in left leg, and right leg had progressed to complete paralysis. (f) Four months after onset, complete paraplegia plus weakness of right hand. Coughing, sneezing and yawning caused sharp pain in both arms. There was no history of venereal or other disease.

Physical examination showed the presence of: (1) Spastic paraplegia with increased knee and ankle jerks. (2) Absent plantar response. (3) Symmetrical atrophy of both lower limbs, also of the hypothenar muscles of the right hand. (4) Sensory level perfectly definite at cervical vi and vii, below which pin-prick was entirely lost; touch sensation much diminished, especially on the left side. Below the sensory level was a well-developed Brown-Sequard syndrome. Temperature sense was lost. Joint position lost in the toes. Vibration lost below the level of the pelvis. Deep pain lost in the calves. *X-ray pictures* were negative. *Blood and spinal fluid* negative. *Manometric test* showed complete block. *Pre-operative diagnosis:* Tumor of spinal cord at level of cervical vi, right side.

Operation.—January 20, 1927, a right hemilaminectomy of the v, vi and vii cervical vertebræ was done. When the laminæ were removed six and seven were somewhat thinned and beneath them there became visible a tumor, dark in color, elastic in consistency and with very marked pulsation, such that it was suspected of being an aneurism for a time. Further exposure showed it to be ventro-lateral, extradural, extending from the sixth intervertebral canal, which was expanded to 1.5 cm. in diameter, inward and upward along the ventro-lateral aspect of the dura. It was largest about 1 cm. from the upper end where it evidently caused the most compressoin of the cord.

It was enucleated by sharp dissection and when completely removed showed both the anterior and posterior nerve roots of cervical vii incorporated in the tumor, most of the fibres lying between its capsule and the surface of the tumor proper. The dura was not opened.

His post-operative recovery was very rapid: (a) Within twenty-four hours he began to move his legs. (b) Four days after operation there was increased voluntary movement of toes, ankles, knees and hip-joints. (c) Sensation to pin-prick and touch returned on the left side. (d) Sensation to pin-prick and touch returned over the sacral area on the right side. (e) Deep sensibility, joint position, deep pain, vibration—unchanged. (f) Urinary precipitancy—gone. Progress has been very rapid since that time, he being able to walk with some assistance in balancing on the nineteenth day.

Pathological Diagnosis.—Neurofibroma.

Remarking upon this case the reporter said that inasmuch as a number of cases have been reported in which bilateral cervical laminectomy has been followed within a few months, or a year or two, by dislocation of the cervical spine, it would seem wise to adopt a method which would preserve as much

of the bones, ligaments and muscles as possible, in order to preserve the stability of the spinal column.

In one case reported by Adson there was sufficient dislocation to have caused complete transverse myelitis, which later resulted in death.

Two cases reported by Mixter showed perfectly definite dislocation; in one case without symptoms, and in the other case, which had passed from observation, a late fatal result which may or may not have been the result of forward dislocation.

In a fourth case, in which a patient after complete bilateral cervical laminectomy returned after two years with well-marked disturbance of all four extremities, definite angulation with forward dislocation of cervical iii on iv is shown. It is probable that his neurological symptoms are not due to this dislocation at the present time. Nevertheless, the changes in the cervical column are certainly ominous for the future.

Every laminectomy in the cervical region should therefore be primarily a hemilaminectomy for the purpose of exploration and then if occasion demands it, bilateral laminectomy may be done readily over as much or as little of the opposite side of the spine as may be necessary.

CHRONIC INFLAMMATION OF CAUDA EQUINA

Doctor Taylor presented a third patient, a man, aged fifty-five years, who was admitted to Bellevue Hospital, November 1, 1926, with a history of: (a) Sharp pain in both lower extremities since October, 1925. (b) Pain rapidly extended into the lumbar region, followed by difficulty in walking, in May, 1926. (c) Sphincter disturbance developed in August, 1926.

Physical examination showed: (1) Atrophy and weakness of the glutei, ham-strings and calf muscles on both sides. (2) Ankle-joints lost on both sides. (3) Left knee-joint lost; right knee-joint diminished.

Sensory examination showed loss of sensation in the sacral ii, iii, iv and v on the right side and sacral iv and v on the left side. *Manometric test* showed no block. *Lipiodol injection* showed a lesion at the level of the fifth lumbar vertebra. *X-ray plates* also showed considerable osteo-arthritic disturbance of the lower spine.

November 10, 1926, he was subjected to a right hemilaminectomy from lumbar iii to sacral i, inclusive. The muscles were thick and the wound was at considerable depth, so that the procedure was somewhat difficult. When the dura was exposed it was found that there was a perfectly solid, hard tumor about 3 cm. long and apparently 1.5 to 2 cm. in diameter which lay just in the midline and which could not be satisfactorily exposed or dealt with through a hemilaminectomy. Therefore, the exposure was converted into a bilateral laminectomy. The dura was split over the hard tumor which, when exposed, proved to be most of the cauda equina matted into a hard mass by a chronic inflammatory process. After this mass had been separated into the various nerve bundles, a projection was felt extending backward from the anterior wall of the spinal canal, between lumbar v and sacral i. This projection was smooth and extended somewhat across the front of the spinal canal. It was thought to be a chondroma. The anterior layer of the dura was divided vertically as well as the posterior spinal ligament. Spinal fluid was constantly coming into the wound and when the dura and the vertebral ligament were divided, the flow was considerable.

On attempting to feel the tumor over which the incision had apparently been made, it could no longer be distinguished and a probe passed through the incision freely into the space between lumbar v and sacral i. Evidently the disc had liquified and this liquid, under tension, had projected backward,

simulating a chondroma and then had escaped through the incision, mingling with the cerebro-spinal fluid.

There was a slight improvement in the neurological condition following the operation. There was very marked relief from his pains until he began to sit up.

In view of the complete laminectomy and the obvious damage to the intervertebral disc, it was felt necessary to have a well-made support before he was allowed to get up. Therefore, a plaster jacket was applied to lift the weight of his torso from the spine and put it on the iliac crests. In this case, had hemilaminectomy been feasible for the completion of the operation, it would have been possible to do a fusion of the remaining arches and spinous and articular processes, which would have given him earlier relief from the external supporting apparatus.

Dr. Thomas A. Shallow (of Philadelphia) said that the question of the use of hemilaminectomy as a primary procedure in all tumors of the spinal cord should be questioned. It is true that in certain limited cases the exposure of the cord or the dura of the cord is all that is sufficient for a proper extirpation of the growth. In certain cases a complete laminectomy is not only advisable but imperative. This is stated with a full realization of the points brought out by Doctor Taylor of tumors of the cervical region where a complete laminectomy had been performed on several of the lamina. Doctor Taylor admits that under certain conditions a complete laminectomy is absolutely necessary for the completion of the operation. He claims that it requires not more than ten minutes to convert a hemilaminectomy into a complete laminectomy. There is valuable time lost after the dura has been opened and the cord exposed; it is at this period in the operation when shock plays a strong rôle in the question of mortality. The speaker believed that in all tumors involving the membrane in front of the cord and tumors within the cord a complete laminectomy is obligatory.

In the tumor of the substance of the cord in the cervical region which Doctor Shallow operated upon, he believed it could not have been removed through a hemilaminectomy, and was sure that had he had only a hemilaminectomy to begin with and then converted this into a complete one, he would have lost his patient through shock on the table from the added ten minutes of exposure of the cord.

Dr. Charles A. Elsberg said that since Doctor Taylor had reintroduced the curved incision instead of the cross-bow incision which everyone took up on Cushing's advice, surgeons have been using the single incision more and more often. For many years Doctor Elsberg was opposed to the operation of hemilaminectomy, mainly because the operation is not quite as simple and one could not obtain as free and wide exposure of the spinal canal, and because—in operating around the spinal cord—it is of great importance to handle the cord as little as possible. Consequently he felt that a complete laminectomy was indicated in all instances except where the nerve roots on one side only were to be divided. He thinks, however, that the arguments Doctor Taylor has presented for hemilaminectomy, especially in the cervical

region, are very good ones and that he is right when he says one should begin with hemilaminectomy and then, if necessary, increase the bone removal until both laminæ and spinous processes have been removed. In Doctor Taylor's case of extra-dural tumor it would seem there may already have been some bone changes. But that does not interfere with his argument, which is an excellent one, and in the future, Doctor Elsberg said he will do hemilaminectomy in the cervical region more often.

Dr. A. P. C. Ashhurst (of Philadelphia) asked Doctor Taylor if he had had trouble from sloughing of the scalp as a result of cutting the occipital artery on both sides. The speaker previously had used the cross-bow incision of Cushing, but he had one patient who had extensive sloughing of the scalp and after that he heard of similar experiences in the hands of other surgeons, because the occipital artery was divided low down. Then his associate, Dr. Temple Fay, called his attention to the midline incision from the inion to the upper cervical region, as described last year by Doctor Frazier, securing more room if necessary by dividing the spinal muscles from within outward below the distribution of the occipital artery. This gives good exposure and there is no subsequent sloughing.

Doctor Taylor, in closing the discussion, said that he had been doing hemilaminectomy since 1903 and had removed good-sized tumors from within the dura, dividing the posterior roots up both sides; in other words, he got good exposure. Doctor Elsberg and he had discussed this from different points of view for fifteen years and it was pleasant to learn that they were now in accord. It takes a certain amount of facility to acquire the amount of exposure this procedure may give. All those things, regarded as difficult for hemilaminectomy, have been done and the patients have gotten well and stayed well if the proper tools were employed. Of course one cannot get as free and wide an exposure as if one takes both sides to the same degree, but one can get sufficient, so why waste the bone on the other side? Then, too, if hemilaminectomy is done and a lesion is found that cannot be satisfactorily handled through hemilaminectomy, it can be translated to double laminectomy in two minutes. In the old days when neurological localization was not as good as it is now, it was always a possibility that the tumor would be found to be far above or below the apparent localization, and if full laminectomy had been done very little spine was left when the tumor was finally removed. But exploration could be done through hemilaminectomy and then, if more room were needed, it could be taken without so much damage. As to Doctor Ashhurst's question, Doctor Taylor said he had never seen sloughing in this incision and thought there must have been something unusual in Doctor Ashhurst's case. So many had been done without any sloughing that when it occurred the cause must lie elsewhere, than in the division of the occipital artery. With regard to the midline incision, the speaker was attracted by that for cerebellar tumor as it gives good exposure. He had been enabled by it to handle a left lobe cystic glioma successfully.

DILATATION AND PERFORATION OF THE CÆCUM IN OBSTRUCTION OF THE DESCENDING COLON OR SIGMOID

DR. JOHN DOUGLAS said that if, as the result of complete obstruction, the intestine above the point of closure becomes sufficiently distended, perforation may ensue. Usually, the maximum distention and perforation occurs immediately proximal to the point of obstruction. Perforation probably occurs only as a result of mechanical ileus. In the small intestine it is usually located on the intestinal surface most distant from the mesentery.

It has been shown experimentally and clinically that the mechanism of this process depends on interference with the blood supply, due to pressure from within the intestinal lumen acting on the thin wall and narrow lumen of the vessels. This pressure obliterates first the veins, which rupture and cause blood extravasation. Then the additional pressure occludes the arteries and necrosis of the intestinal wall results.

In the large intestine, location of the maximum distention may not be immediately above the point of obstruction, but may be at some distance proximal to this point. That is, in obstruction of the descending colon or sigmoid, great distention of the cæcum may occur, which may result in splitting of the serous coat of the cæcum, or even terminate in perforation and general peritonitis. This condition has a bearing on diagnosis; complicates the symptom complex; and may have a determining influence on the operative procedure. His attention was first directed to this condition by the following case:

A woman, age sixty-five, was admitted to St. Luke's Hospital, June 26, 1924, with symptoms of acute intestinal obstruction. Constipation and gas pains had been present for four months. For ten days before admission she had cramp-like pains in the abdomen with dull pain on the left side under the ribs. Bowels had not moved for forty-eight hours, and vomiting had been persistent for twelve hours. Radiograph, after opaque enema, showed obstruction at the junction of the descending colon with the sigmoid, and marked gaseous distention and dilatation of the cæcum. At operation, an annular carcinoma of the descending colon was found, but the cæcum was so distended that the peritoneal coat had split along a distance of 4 to 5 cm. Although the small intestine and colon between the cæcum and point of obstruction were also distended, the dilatation was far less than that of the cæcum. The condition of the cæcum made it advisable to perform a cæcostomy rather than to attempt immediate delivery of the growth which was above the sigmoid, making mobilization difficult. The resection of the growth was done at a later stage and the cæcostomy closed at a third operation. There have been no signs of recurrence to date.

While this dilatation of the cæcum has been frequently observed, even proceeding to the degree of splitting of the serous coat during operation, it is not well known by the majority of surgeons. Still less so is the fact that as a result of low obstruction in the large intestine the cæcum may become distended to the degree of perforation. This is illustrated in the two following cases:

A man, age fifty-four, was admitted to the Knickerbocker Hospital, November 19, 1924, with a history of general abdominal pain for ten days, finally localizing in the right lower quadrant. Very small movements from

bowels at first, later none. Had vomited frequently, but had continued working and had no medical attention until day before admission to the hospital, when all symptoms became worse. He was admitted in a moribund condition with all the signs of advanced general peritonitis, and died within a few hours, no operation being done. At autopsy, a carcinoma at the rectosigmoid junction was found, and a general peritonitis, due to fecal extravasation from a perforation of the cæcum at the base of the appendix.

A man, age sixty-five, was admitted to Bellevue Hospital, April 19, 1925, with history of constipation for six days; vomiting five days; distention and pain increasing up to admission. The history indicated intestinal obstruction —the physical signs of general tenderness and rigidity, with elevated temperature and blood count, a general peritonitis. At operation, a carcinoma of the pelvic colon was found with a general peritonitis, due to perforation of the cæcum. A cæcostomy was done, but the patient died thirty-six hours later.

These cases are not presented to illustrate a new observation, but to recall to mind an old one apparently not known, or forgotten, by many. Twenty-five years ago, in 1902, Willy Anschutz, in the *Archives für Klinische Chirurgie*, Bd. lxviii, p. 195, published a report of five cases of obstruction, two of carcinoma of the splenic flexure, two of the sigmoid, and one case of volvulus of the sigmoid. All showed great distention of the cæcum, and one had perforated with resulting peritonitis. He explains this phenomena in certain cases by the resistance of the ileocæcal valve and the fact that the normal diameter of the cæcum is greater than that of the rest of the colon. That this distention should be greater, therefore, in the cæcum by natural physical law he proves by attaching two rubber finger cots or balloons of different diameters at the ends of a T-tube and injecting air at the centre. Although the walls of the balloons were of equal thickness, the one of larger diameter always became the more greatly distended.

It has seemed worth while to recall attention to this condition, as, should the physical signs or the X-ray evidence as shown by a plain plate, of a greatly distended cæcum, in the presence of symptoms of intestinal obstruction, be present, it may point to the possibility of the obstruction being low in the colon. Also this cæcal distention, resulting in pain, and tenderness on the right side may cause a mistaken diagnosis of appendicitis to be made, as was the case in a patient with a carcinoma in the lower part of the sigmoid recently seen. It is also suggested that this tendency of the cæcum to dilate more than other portions of the colon, when the ileocæcal valve is especially resistant, may have some bearing on the vague, irregular, right-sided pains in constipated patients, thus causing a faulty diagnosis of chronic appendicitis to be made.

MEGACOLON

Dr. Richard W. Bolling presented two patients as illustrating one of the problems in the treatment of megacolon, or speaking more correctly, of megasigmoid and megarectum. As the anatomical condition was similar, the two cases were presented together.

They were both admitted to the medical side of St. Luke's Hospital in the summer of 1922, at which time one was thirteen and the other fifteen years of age. In both the immediate history was of abdominal pain, diarrhœa and loss of weight. In the case of the younger boy there was a history of stomach trouble and constipation since birth and he had been under obser-

vation at the hospital for one year with recurring attacks similar to the present one. The older boy had a definite history for only one month. In each patient there was an enormous fecal impaction, with greatly dilated rectum and sigmoid colon.

After the relief of the immediate symptoms, the patients were transferred to Surgical Division "A" and assigned to Doctor Bolling for treatment. After careful consideration, resection of the sigmoid colon was carried out and a little over two feet removed in each instance. This portion of the intestine was greatly dilated and the wall thickened. The process obviously involved the rectum. The remainder of the large intestine was relatively normal, though in one case considerably dilated. In this case an axial anastomosis was effected. In the other a lateral anastomosis was carried out on account of the great disparity in the size of the dilated rectum and the apparently normal descending colon. Convalescence was uneventful and within a year one patient gained 22 and the other 29 pounds.

The younger patient was shown to this society May 9, 1923. There persisted in both patients a marked tendency to constipation and in the second and third year after operation, each patient had an attack similar in all respects to the ones before operation. Since that time there have been no attacks of such severity and although evacuation of the bowels is irregular, the condition is kept under fair control by the patients themselves. The involvement of the rectum was fully recognized at the time of operation, but the operation was performed in the hope that removal of the sigmoid loop would increase the efficacy of ordinary medical measures.

Cases such as these should not, in Doctor Bolling's opinion, be included in the group of so-called idiopathic dilatation of the colon, but should be regarded as instances of acquired megacolon resulting from a tendency to fecal stasis due possibly to some developmental defect in the wall of the intestine.

A similar condition is apparently prevalent in Argentina and in 1922 (Corbin, F. G., Megasigmoid, Megarectum, Fecal Bolus. *Surg., Gynæc. and Obst.*, vol. xxxv, pp. 23–34, July, 1922). Doctor Corbin referred to a personal experience of over two hundred cases of fecal impaction with enormously dilated rectum and sigmoid. In his article he makes the statement that more deaths occurred in Mendoza from this condition than from appendicitis, gastric ulcer, duodenal ulcer and cancer of the rectum combined.

In a recent article (Mirizzi, P. L., Total Colectomy as a Treatment of the Megasigmoid. End-to-End Anastomosis. *Archives of Surgery*, vol. xiii, pp. 837–845, December, 1926) Doctor Merizzi, of Cordova, reports recurrence following similar operations and advises total colectomy with implantation of the ileum into the recto-sigmoid.

This procedure would seem scarcely justified in cases such as the ones shown by Doctor Bolling. In the future in similar cases Doctor Bolling will be inclined to defer operation and depend upon medical measures, operating only for volvulus or other acute condition. This of course does not apply to true Hirschsprung's disease, in which the rectum is rarely involved.

CARCINOMA OF THE COLON

DR. RICHARD W. BOLLING presented a man, aged fifty-four, as a recent result of the application of the multiple stage operation in carcinoma of the cæcum. The patient was admitted to St. Luke's Hospital in July, 1926, with a history of epigastric distress for three and one-half years and of a tumor

in the right side of the abdomen for three years. There had been no symptoms of intestinal obstruction, but anæmia, weakness and loss of weight had been progressive. On admission the patient appeared in very poor general condition and his hæmoglobin was 45 per cent.

After transfusion, Doctor Bolling operated and found a bulky growth in the cæcum. The cæcum and ascending colon were freed in the usual manner. The growth in the cæcum, with the adjacent ascending colon and ileum, was exteriorized and cut away with the cautery, after the walls of the ileum and ascending colon had been united. A tube was introduced into the ileum.

The first operation was carried out July 20. A clamp was applied to the spur a few days later and the fistula was closed August 19. The patient was discharged September 11. A small sinus persisted for several weeks but the wound is now soundly healed.

This type of operation is not usually indicated in growths of the cæcum, but there are exceptions in which its application is very useful.

Doctor Bolling presented also a woman who was admitted to St. Luke's Hospital in March, 1922, with a history of diarrhœa, abdominal distention and loss of weight. At that time she was twenty-six years of age.

Röntgen-ray examination indicated partial obstruction in the lower sigmoid and the sigmoidoscope revealed an irregular growth eight and one-half inches from the anus.

Doctor Bolling operated and a growth occupying the lower sigmoid and growing into the lumen of the gut was found. Resection of the growth with immediate axial anastomosis after the tube method was done. The pathological report was adenocarcinoma of the sigmoid without involvement of the regional lymph-nodes.

Convalescence was uneventful and the patient was discharged twenty-one days after operation. Following her discharge she received a series of Röntgen-ray treatments and a temporary artificial menopause was induced. She was married about three years ago and recently consulted Doctor Bolling in regard to a perineal laceration sustained at the birth of a child two years ago.

She has no symptoms referable to the original condition and it is now a few weeks less than five years since her operation.

TUMORS OF THE CÆCUM

Dr. John F. Erdmann (of New York) read a paper with the above title, for which see page 722.

Dr. George P. Müller (of Philadelphia) said that he had had nine or ten cases of carcinoma of the cæcum, three of tuberculosis and one case of undetermined origin. This patient was a young Japanese who for three years had had slight pain in the right iliac fossa. Recently there had been an acute exacerbation. The pre-operative diagnosis was acute appendicitis. At operation the mass was found to be in the wall of the cæcum and about four cm. in diameter. It was thought to be cancer or tuberculosis and the cæcum and ascending colon were removed. The mass in the cæcum was a localized abscess in the wall which on culture was found to be sterile. The cases of tuberculosis were of the hyperplastic variety in two instances and one was ulcerated. This man had no other evidence of tuberculosis, yet he

had a thickened ascending colon containing five ulcers. All of the cases of tuberculosis recovered. In regard to carcinoma of the cæcum, the speaker had noted that Doctor Erdmann had eighteen cases as compared to approximately twenty-two on the left side. Usually the proportion is found to be greater. The speaker believed that in these right-sided tumors obstruction is uncommon; very few of his had acute obstruction. When the end of the ileum was involved the obstruction was chronic and the small bowel hypertrophied. Pain was of more consequence than on the left side. His experience with the X-ray is that of Pancoast who thinks the picture of cancer undistinguishable from that of tuberculosis of the cæcum. Doctor Erdmann had referred to the finding of Craig and McCarty, that in 32 per cent. the lymph-nodes were involved. It is better to put it the other way and state that in sixty-eight there is no metastasis to the lymphatics; hence there is a good chance of curing carcinoma of the cæcum. The operation is very easy. The speaker said he usually makes his incision closer to the bowel than pictured by Doctor Erdmann. In resection for cancer of the cæcum he has had no trouble with the duodenum. Only in carcinoma of the hepatic flexure is one liable to run foul of the duodenum. Regarding the method of operation, Doctor Müller said he had done end-to-end anastomosis and end-to-side, and had found no difference. In the end-to-end one has to trim the bowel, and the speaker was more partial to the end-to-side method. Lateral anastomosis has given him an obstruction in two cases. If there is considerable obstruction a preliminary operation must be thought of, but there is danger of infection from a preliminary ileostomy. So unless there is a real shut down, it is better to do the entire procedure at one time. Doctor Müller agreed with Doctor Erdmann that infection is common. These patients are septic and one has to work carefully. Most of the speaker's cases had bled and some he had had to transfuse. One patient had an ileostomy and then bled and was transfused two or three times. At the operation to remove the growth it was found that it had advanced so far during this period of three months as to be inoperable.

Dr. Joseph A. Blake said in regard to the malignancy of right-sided growths, he had found them to be more so than on the left side of the abdomen. Recurrences had usually taken place within five years, and some in a very short time. The last recurrence, or rather extension, which he had observed only that day, was in a woman twenty-eight years of age, from whom the cæcum ascending colon and terminal portion of the ileum had been excised for carcinoma of ileocolic junction eight weeks ago, at which time the ovaries were normal, but to-day both were found to be the site of carcinomatous growths six inches in diameter. Some of these tumors are very malignant, much more so than those occurring in the sigmoid. There is a low malignancy in carcinoma arising in the appendix which lowers the general mortality of right-sided carcinomata. Doctor Blake said he had generally done the end-to-side anastomosis.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held February 23, 1927

The President, Dr. Walton Martin, in the Chair

CÆCAL ULCER—LYMPH-NODE HYPERPLASIA

Dr. Otto C. Pickhardt presented a girl, five years of age, who was admitted to the Lenox Hill Hospital, February 20, 1923, on account of pain in the abdomen, which had lasted for four days. Examination showed the abdominal wall normal to pressure on left side, right side spastic. Just external to the border of the right rectus, there could be felt a tender mass about two inches long and three-quarters inch broad, not movable and unyielding. Child was kept under observation for ten days, during which time the bowels moved regularly. May 5, 1923, abdominal incision revealed an irregular growth of lymph-nodes between the folds of the mesentery of the ascending colon, extending up to and partially surrounding the gut to the hepatic flexure and downward to the ileo-cæcal junction. The mesenteric lymph-nodes of the distal six inches of the ileum were also involved. The lumen of the involved portion of the gut though patent was still so much reduced that the operative procedure at this time was limited to an end-to-side anastomosis of the ileum with the mid-portion of the transverse colon and the removal of two of the nodes for examination which showed simple hyperplasia and œdema, no evidence of tuberculosis or malignancy. A good operative recovery followed. Two weeks later there was done a resection of the terminal four inches of the ileum, cæcum, ascending colon complete and three inches of transverse colon, together with the mass of retroperitoneal lymph-nodes. At this time it was found that the mass had decreased materially in size and that perfect healing of the anastomosis previously done, had taken place. The first week after operation was somewhat stormy, but by the eighth day, temperature was normal, bowels moved regularly, incision had healed by primary union. Examination of the mass removed showed suppurative colitis with perforation, chronic pericolitis and lymph-node hyperplasia. Two centimetres above the ileo-cæcal valve was a small perforation extending directly into a mass of lymph-nodes. The track of the perforation was lined with granulation tissue and covered in places with cylindrical epithelium derived from the mucosa of the gut. In places minute abscesses are present and giant cells of a foreign body type occasionally seen. Cause of lesion was not determined. Since her recovery she has remained well and developed as a normal child, except for an effusion into the left knee-joint, March, 1924. Abdomen is somewhat big, scars are firm, bowels move regularly twice a day. Now, practically four years after the resection at the age of nine, she is well, four feet three inches in height and weighs fifty-three pounds.

OSTEOGENETIC SARCOMA OF HUMERUS

Dr. Otto C. Pickhardt presented a woman, age twenty years, who was admitted to Lenox Hill Hospital, July 17, 1924, on account of pain and inability to use her left arm. Pain in upper left arm was first noticed six

months ago. No history of trauma, swelling, redness, or other external physical signs. Examination showed an evident pathological fracture just below the greater tuberosity of the left humerus. No axillary lymph-nodes felt. Blood count shows distinct secondary anæmia. Wassermann examination is negative and X-rays show about two inches below the greater tuberosity there is an area of bone destruction. The appearance is rather suggestive of a medullary growth, possibly sarcoma. There is no appearance of metastatic growth in the lungs. In July, 1922, a biopsy was performed and curettings from the medulla of the humerus obtained. There appeared to be a sort of capsule around the fracture and the muscle seemed normal and not infiltrated.

Pathological examination showed tumor cells varying considerably in size and for the most part fairly large. The cell outlines are poorly defined though the cells appear polyhedral or round in shape. The cells show chromatic nuclei and a slightly acidophilic granular cytoplasm. Mytotic figures are numerous. There are a number of true tumor giant cells and giant cells of the foreign body type, the latter cells being most numerous in the fibrosarcomatous areas. *Diagnosis:* Actively growing sarcoma of the humerus.

July 28, 1924, a disarticulation of the left arm at the shoulder-joint was performed and the axilla cleaned out. As much muscle as possible was cut away with the arm from the shoulder, leaving the acromion and the coracoid processes bare. There was no evident direct extension visible in muscle, and the muscle and lymph-nodes were soft and hyperplastic. Pathological examination of the lymph-nodes showed no evidence of metastasis. Post-operative recovery was normal except for some referred pain in the ulna and some sloughing of the skin flap and fat necrosis with infection in the axilla.

The patient had received before operations two deep X-ray treatments and post-operatively received three more. She left the hospital, September 13. February 8, 1926, she was re-admitted with an acute spontaneous right pneumothorax. No cause for this could be ascertained, and X-rays showed no evidence of metastasis or tuberculosis. This condition cleared up in seventeen days and she left the hospital. During the whole of the intervening time between the disarticulation and the present, which is now two and one-half years, except for the pneumothorax, she has had only minor ailments. She has complained of pain in the corresponding region of the right humerus, which has been attributed to a hypertrophy of the deltoid muscle and she has occasional headaches attributed to her persistent secondary anæmia and eye-strain. All X-rays of the right arm, lungs, and skull, are persistently negative for metastases. This patient is shown (1) because of her apparent freedom from metastases after two and one-half years, and (2) because a comparatively conservative operation has enabled her to support herself as an embroiderer during this period.

RE-FORMATION OF ULNA FOLLOWING EXTENSIVE OSTEOMYELITIS

Doctor Pickhardt showed also a boy, five years of age, who was admitted to the Lenox Hill Hospital, November 24, 1919, on account of pain and swelling of the left forearm which had been progressively increasing for one week. When admitted the left forearm was swollen, tender, red, and fluctuating along the outer border over the ulna. This area extended from the wrist to within a short distance of the elbow. Other extremities normal. The same day the limb was subjected to incision and drainage; six ounces of thick, yellow pus were obtained, which on culture showed staphylococcus aureus. Following this, five more operations were performed. At the fourth

FIG. 1.—Massive osteomyelitis of ulna. Skiagraph taken March 1, 1920.

FIG. 2.—Same forearm shown in Fig. 1, after lapse of seven years.

operation, December 18, a small sequestrum from the ulna was obtained. An X-ray at this time revealed an osteomyelitis of the entire shaft of the left ulna; extensive sequestration has occurred. March 10, 1920, an incision was made from the wrist to the elbow-joint over the ulna. A sequestrum was found free at the lower end and loose within the involucrum, and removed. A few smaller sequestra were also removed. X-ray at this time reveals an old osteomyelitis of the whole ulna. (Fig. 1.) There is a formation of involucrum almost the entire length of the bone. The entire shaft has now become a sequestrum. Following this last operation, the wound healed without further difficulty, and the patient was discharged April 7, 1920.

The patient was lost track of until he returned to the Lenox Hill Hospital, January 15, 1927, because of a dense mass in the right axilla. This proved to be a chronic tuberculous lymph-adenitis and the mass was removed on January 20, 1927. At present there remains a small sinus.

An X-ray of the left forearm seven years after the practically complete removal of the ulna shows almost complete regeneration of the bone. (Fig. 2.) It has grown evenly with the radius and only in its upper end does it show any roughening that would point out the location of the old trouble. The coronoid process is one cm. longer than on the right side.

Present examination of the left forearm shows the old scar somewhat adherent to the ulna. Viewed anteriorly there is no deformity. There is present the same power as in the right normal forearm. There is perfect pronation and supination. Flexion is normal and the only abnormality is a loss of about five degrees in extension because of bony impingement. The case is shown because of the unusually perfect re-formation of a bone after an extensive osteomyelitis.

RE-FORMATION OF RADIUS FOLLOWING EXTENSIVE OSTEOMYELITIS

Dr. DeWitt Stetten presented a young man, seventeen years of age, who in November, 1919, when nine years old, following a slight trauma, began to complain of pain, swelling and redness of the left wrist. He had high temperatures and there was a point of exquisite tenderness on the radial side of the left wrist. X-ray examination showed a small defect in the bone on the radial side of the lower end of the diaphysis of the radius, and some elevation of the periosteum in this region. December 4, a large subperiosteal abscess was opened and drained, and the lesion in the lower end of the diaphysis of the radius was thoroughly curetted. Culture of the pus showed a staphylococcus aureus infection. This procedure, notwithstanding the osteomyelitis, extended through the entire radius. January 3, 1920, the entire radius was opened and converted into a long boat-shaped cavity. The entire shaft of the radius thereupon sequestrated with a certain amount of involucrum forming, particularly at the upper third. February 19, 1920, the sequestrum was loose, and after dividing it in its middle with a circular saw, the two halves were extracted. (Fig. 1 A.) Some disintegration was noted at each end, especially at the lower. February 28 an abscess was incised on the inner side of the arm, and May 18 another incision on the radial side of the forearm was made below the elbow, some pus was evacuated from a probable elbow-joint abscess, and two loose fragments of the radial head were removed. (Fig. 1, B.) The sinuses at the wrist and at the upper angle of the main wound were curetted. Within the next two months all the wounds healed and remained closed. No regeneration, however, occurred in the middle third of the radius, so that a defect of about three and a half inches persisted. This resulted in a false joint in the middle of the forearm and marked radial adduction of the hand in spite of all efforts to prevent this

deformity, so that function of the forearm was markedly interfered with. November 21, 1921, nearly two years after the initial infection, and about a year and five months after all wounds had entirely healed, the defect still remained unchanged and an inlay bone graft operation was performed. The skin was excised, the exposed pointed ends of the regenerated upper and lower segments of the radius were exposed and removed, and a V-shaped mortise was made at each end. A section of the left tibial crest with periosteum was taken for the graft and the ends of the graft shaped to fit the mortise, so as to fit snugly into the defect with the hand in as full ulnar adduction as possible,

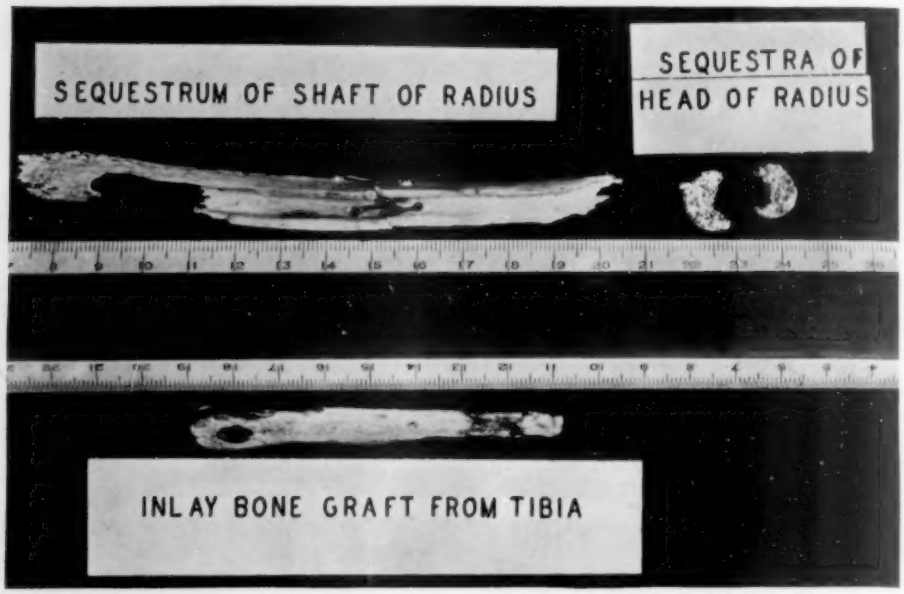

FIG. 1.—*A*, Sequestrum of shaft of radius after previous osteotomy. Sequestrum has been divided in middle for purpose of extraction and is held together by wires. *B*, Sequestra of head of radius. *C*, Inlay bone graft, removed because of suppuration.

considering the contraction of the radial muscles. Holes were drilled into the upper and lower segments of the radius and at each end of the graft, and the graft was secured in place at each end by kangaroo ligatures. Unfortunately, the wound did not heal by primary union, probably because of the persistence of pyogenic bacteria in the tissues, and December 3, 1921, it was necessary to open the wound and evacuate some pus. X-ray examination December 19, 1921, showed some callus forming around the upper end of the graft and some bone absorption in the lower fragment of the radius around the lower end of the graft. (Fig. 2.) December 20, 1921, another small abscess was opened. The wound continued to drain but no attempt was made to disturb the graft. February 21, 1922, X-ray examination showed the graft still in place but somewhat disintegrated, considerable more bone absorption in the lower end of the radius around the lower fragment of the graft, and a thin bridge of bone connecting the two radial fragments. April 6, 1922, the graft was removed. It was considerably disintegrated, particularly at the upper end. (Fig. 1, C.) After the removal of the graft there was apparently no false motion in the radius which appeared now to be a solid bone. X-ray examination showed that the bridge of the bone connecting the upper and lower radial segments had increased considerably in size, and that the area

of bone absorption in the lower fragment was filling in. After the removal of the graft the wound healed promptly and has not reopened since. The connecting bridge of bone between the upper and lower fragments of the radius rapidly increased in density (Fig. 3), and the patient soon began using the arm for every purpose and apparently without any marked disturbance. The reporter had not seen the patient for five years. He has had no

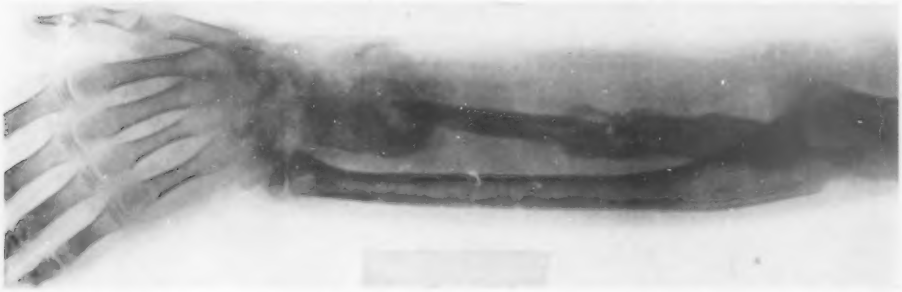

FIG. 2.—Radiograph about one month after inlay bone graft operation to bridge persistent defect in middle third of radius. Note beginning callus formation around upper end of graft and bone absorption in lower end of radius and around lower fragment of graft.

trouble with his forearm since. Although there is still a rather noticeable deformity with a marked concavity of the radius and some radial adduction of the hand, function of the wrist, and especially the elbow, are almost normal in spite of the previous apparent elbow-joint suppuration. Supination, however, is rather definitely restricted. X-ray examination shows an astonishing restoration of the radius. The regeneration has been quite complete, including the radial head. The bone is comparatively little deformed with only slightly increased density in the middle third in the region corresponding to the persistent defect, only a moderate thickening of the lower third, and only slight ulnar and posterior bowing. The growth of the radius has been relatively normal, keeping good pace with that of the ulna. (Fig. 4.)

This case is presented first, to show the extent to which regeneration can replace a long bone after practically complete sequestration, and second, to

FIG. 3.—Radiograph six months after inlay bone graft operation, and seven weeks after removal of graft. Note bridge of solid bone between the two radial segments.

illustrate the value of an inlay bone graft to complete an imperfect restoration. It is interesting to note that the effect of the graft was quite satisfactory in spite of suppuration, and the eventual necessity for removal of the graft. Apparently the presence of the graft stimulated the bone formation from either end of the radial segments, or sufficient osteogenesis proceeded from the periosteum of the graft to completely bridge the defect.

Dr. J. P. Hoguet believed this condition was not as rare as has been believed. He had personally seen three such cases, one of which he reported before this Society three years ago in which the whole shaft of the humerus was removed in February following an osteomyelitis caused by a compound fracture received the previous June. At the time of operation a new humerus had already formed around the sequestrum. This patient was a boy twelve years of age who had had a severe cases of osteomyelitis and the sequestrum extended from the proximal to the distal epiphysis.

Dr. Joseph Wiener questioned if the bone inlay had anything to do with the result in these cases. Years ago he operated on a boy who, following a

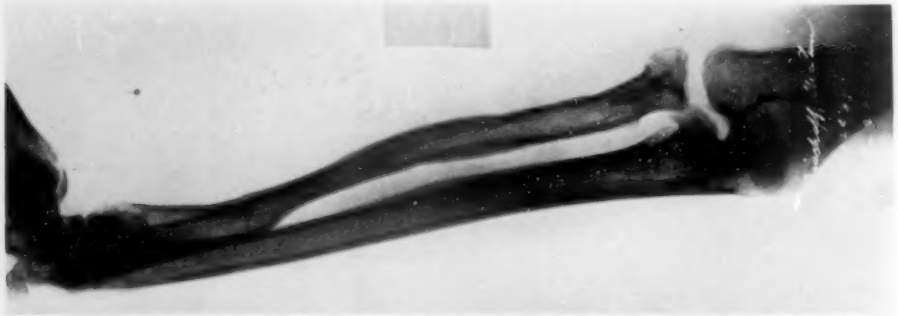

Fig. 4.—Radiograph seven years after almost complete sequestration of radius, and two years and two months after inlay bone graft operation. Note complete reformation of radius, including radial head, with relatively little deformity.

streptococcic throat, had had osteomyelitis of the radius. In cutting down on the radius he split the periosteum which was already loosened from the bone. He lifted out the entire radius from the wrist to the elbow in one mass. There was subsequently perfect re-formation of the bone. Doctor Wiener believed that the periosteum did all the work of re-formation of bone in these cases.

Doctor Pickhardt, in closing the discussion, said that the length of time it took this ulna to sequestrate was three months and three weeks, nearly four months. Before the last operation the X-ray showed an apparently perfect sequestrum, but at operation it was found the sequestrum was not loose and so no attempt was made to remove it. The criterion by which one should judge the arrival of the time for the removal of the sequestrum is its complete separation—in other words, when it is completely cast away as a slough and is lying loose. Probably the type and severity of the infection have something to do with the length of time, as well as the age of the patient. This case was not shown for its rarity but for the good result which nature obtained.

Doctor Stetten, in closing the discussion, said that he waited nearly three months before removing the sequestrum of the shaft of the radius, which had become quite loose by that time. X-ray examination then showed some involucrum, particularly of the upper third and around the lower extremity, but nothing in the middle third of the bone. The case was kept under a period of observation for nearly two years after the initial infection,

one year and nine months after the removal of the sequestrum of the shaft, and one year and five months after all wounds had entirely healed. As there was absolutely no indication of any regeneration whatsoever in this defect in the middle third of the bone during this period, and as a false joint persisted, it was only then decided to perform the inlay bone graft operation. In spite of the fact that the wound did not heal by primary union and it was necessary eventually to remove the bone graft, regeneration began promptly after the bone had been implanted. Periosteum was implanted with the inlay bone graft, and it is possible that this periosteum was the main factor in the osteogenesis. In view of these facts it appears rather certain that had the inlay bone graft operation not been done in this case, at any rate, the regeneration would not have occurred. The failure of the bone to regenerate without the aid of the inlay bone graft was probably due to the large subperiosteal abscess with the extensive destruction of the periosteum.

MESENTERIC THROMBOSIS

Dr. Guilford S. Dudley presented a man who on September 23, 1925, J. B., when thirty-eight years old, was operated upon at Bellevue Hospital (Second Division) for acute suppurative appendicitis. His appendix was removed and the peritoneal cavity drained. His wound healed completely by February 21, 1926, and remained healed until November 30, 1926. He was well until October, 1926. At that time he began to suffer marked discomfort in his right lower abdomen and said that he felt as though there were something within the abdomen. Although this symptom persisted off and on until the onset of his acute illness, he disregarded it as far as possible and continued at his work.

November 30, 1926, violent generalized abdominal cramp-like pain accompanied by repeated vomiting, chills and fever, caused him to reënter the hospital. At this same time the healed drainage track broke open and discharged sanguino-purulent material. Examination showed a fever of 101°; leucocyte count of 27,000 with 91 per cent. polymorphonuclears and tenderness in the right lower abdomen. His abdomen was not rigid or distended and he had had a daily bowel movement until the day preceding admission. No abnormality was detected in his cardiac, respiratory, urinary or nervous systems. He was observed for twenty-four hours, during which time enemata were ineffectual, vomiting persisted, and became fecaloid in type, but his abdomen did not distend.

Operation revealed a six-inch loop of gangrenous small bowel partially rotated upon its mesentery and adherent to the right lateral parieties. The rotation was not sufficient to occlude the bowel lumen and no occluding band of adhesion was present. Between this loop and a nearby adherent loop was a localized intraperitoneal abscess. No foreign body was found. The bowel proximal to the gangrenous loop was but moderately distended and the bowel distal to it was not collapsed. The involved area was removed; Murphy button end-to-end anastomosis accomplished; rubber dam used for drainage; and the abdomen closed. Convalescence uninterrupted; Murphy button passed by rectum spontaneously on the twelfth post-operative day.

Microscopical examination showed relatively normal mucosa of the small intestine, terminating abruptly in necrotic tissue; œdema, hemorrhage and polymorphonuclear infiltration in the submucosa while in the muscularis

and serosa the process appeared somewhat older, as shown by granulation and fibrin. Several fairly large vessels were thrombosed.

Is it reasonable to assume that, during the two months preceding his operation, repeated attacks of partial volvulus occurred and that the resultant trauma to the mesentery resulted ultimately in the thrombosis of its vessels?

RETROPERITONEAL TUBERCULOSIS

DR. GUILFORD S. DUDLEY presented a girl, twenty-six years of age. In 1919, her appendix and a right ovarian cyst were removed. During the year preceding her present illness she suffered from ill-defined gastric symptoms and lost about thirty pounds weight.

December 14, 1926, while at business, she became acutely ill with severe epigastric pain associated with nausea and vomiting and was operated upon at another hospital one and one-half hours later. Lower abdominal adhesions were freed and a right cystic ovary removed. She left the hospital December 24, 1926, and three weeks later was admitted to the Second Surgical Division of Bellevue Hospital with a recurrence of acute symptoms; a fever of 101°; leucocyte count of 14,000 with 82 per cent. polymorphonuclears, no eosinophilia; 4,300,000 erythrocytes and 80 per cent. hæmoglobin. Wassermann reaction negative. A firmly resistant mass, tender to palpation, was present in the upper abdomen. It could not be distinctly outlined, seemed most pronounced in the epigastrium, and although no edge could be felt, consensus of opinion was that the mass represented enlarged liver. Radiographic examination of lungs showed no change; gall-bladder X-ray after ingestion of dye was negative; and gastro-intestinal X-ray series revealed a small ulcer of the lesser curvature of the pars media of the stomach.

The patient was kept under observation for three weeks, during which time her temperature remained at normal level and the upper abdominal mass gradually diminished in size until it could no longer be palpated. On January 25, 1927, she suffered an apparently typical attack of biliary colic without fever, leucocytosis or jaundice.

At operation, February 4, 1927, the gall-bladder, stomach and duodenum were found to be normal. Beneath the posterior wall of the stomach was a large, stony hard, nodular mass extending from the median line to the level of the cardia and in intimate relation with the hilus of the spleen. Extension of the process into the transverse mesocolon prevented the delivery of the transverse colon into the wound. There were no palpably enlarged retroperitoneal or mesenteric glands elsewhere within the abdomen and no gross evidence of tuberculous involvement of the peritoneum. The only accessible portion of the mass was near the median line and from this region a specimen was removed. During its removal, a small quantity of distinct pus was seen and part of the material obtained appeared to be caseous. Direct smear of the pus showed no organisms and a culture remained sterile. The operative wound was closed without drainage and healed by primary union.

Microscopical examination showed the specimen to consist of fat and areolar tissue containing masses of cells characterized by large polygonal cell bodies, slightly granular cytoplasm and small vesicular nuclei. Occasional giant cells containing two to three large nuclei and a number of cells resembling Langhan's giant cells but no suggestion of tubercle formation. In the masses of embryonal fat cells are interspersed fibroblasts, round cells and capillaries. Occasional eosinophilic leucocytes are seen. No mitotic figures or areas of necrosis. Diagnosis: Chronic productive inflammation in fibro-fatty tissue.

This patient was presented because of the interest attached to her clinical course while under observation, and the isolated nature of the intra-abdominal tuberculous involvement.

BRAIN TUMOR

Dr. Joseph P. Hoguet presented a man, forty-six years of age, who entered the French Hospital, October 25, 1926, complaining of persistent occipital headaches, dizzy spells, ringing in the ears and failing eyesight. His neurological examination showed a slight nystagmus, beginning choked discs in both eyes and a left homonymous hæmianopsia. His knee-jerks were exaggerated and he had slight staggering to the left. Blood count and blood-pressure were normal. A spinal tap was done and the cerebro-spinal fluid found to be under considerable pressure. The cell count was normal and the spinal Wassermann negative.

November 4, 1926, a horseshoe-shaped incision was made on the right side of the skull posteriorly and an osteoplastic flap about 2 by 2 inches turned down. The dura was cut through and a tumor found adherent to its under surface and extending deeply into brain substance. As it seemed very difficult to remove the tumor and the patient's condition not being very good, the flap was loosely sutured back in position and the patient returned to bed. One week later the flap was turned down again. It was found necessary to enlarge the opening and this was done by cutting away more bone on one side with a rongeur. The tumor was then separated from the surrounding brain tissue by blunt dissection and removed. The cavity was packed with gauze as the hemorrhage was rather brisk, the flap turned back and the scalp wound partially sutured.

The patient made a good recovery but developed a partial motor and sensory paralysis of the right arm which cleared up shortly, leaving only a slight weakness in the limb.

After hardening in preserving fluid the tumor was found to be two and one-half by three inches in size and pronounced to be an endothelioma.

END RESULT IN RECONSTRUCTION OPERATION FOR CHARCOT'S DISEASE OF THE HIP-JOINT

Doctor Hoguet presented a man on whom he had operated December 28, 1923, for Charcot's disease of the hip. This patient contracted lues in 1913 for which he had been treated for several years. In the beginning of December, 1923, he developed pain in the right hip on walking, and December 17, 1923, he sustained a pathological fracture of the neck of the femur a short distance from its junction with the head. At operation the fracture was found and there was also a large amount of sandy material, that could be scooped out with the fingers, filling the joint. The deformed head of the femur was found loose in the acetabulum, the ligamentum teres having disappeared. The loose head was removed. It was found to be oval, with a great deal of flattening on the upper surface which was rough and uncovered with cartilage.

A typical reconstruction operation according to the method of Royal Whitman was done, from which the patient made a very good recovery. He left the hospital in six weeks at which time he had an extremely good range of passive motion with one inch shortening in the limb. An X-ray taken at that time showed a great deal of new bone formation principally in the upper part of the new joint, apparently in the gluteal muscles, making a new roof for the joint. He discarded one crutch at the end of six months and the other at the end of a year, then using a cane as he had not regained

perfect confidence in the new joint. For a full year he was actively treated with anti-syphilitics, during all of which time the blood Wassermann was negative. A radiograph taken in October, 1926, showed some slight new formation of bone in the roof of the joint, but no extension of the disease into the shaft. When presented the patient had practically a normal range of motion in the joint.

Doctor Hoguet presented a young woman of twenty-six years, on whom he had operated in October, 1926, for a complete ankylosis of the hip-joint following a gonorrhœal arthritis. In this patient the typical reconstruction operation was done, the new head of the femur being covered with fascia lata. She now has practically complete passive motion in the joint but active extension has not returned as yet.

Dr. Howard Lilienthal called attention to one point made by Doctor Hoguet which he thought should be emphasized, and that was the remarkable shelf of bone which formed to make a new point of application for the femur; he wondered if this formation could always be expected in cases of this sort. Doctor Hoguet had apparently been surprised to find this bony outgrowth. The speaker had never seen anything like it before.

Dr. Fenwick Beekman said that he had seen a case of dislocation of the hip with a fracture of the acetabulum where a new acetabulum was formed above the old, very much like that shown in the röntgenogram of Doctor Hoguet's case.

Doctor Hoguet, in closing the discussion, said that one reason he wanted to show these cases was that although he had seen a number he is still uncertain regarding the outcome. Doctor Whitman has a number of which he has done for osteoarthritis in which this roof of bone has not occurred. What the speaker wanted to bring out in the second case was the fact that, in spite of reaming out the new acetabulum and covering the new head of the femur with fascia lata in this case, the new head of the femur jumped out of what was intended to be the new acetabulum and formed another acetabulum with this roof of bone.

BRACHIAL PLEXUS PRESSURE BY THE NORMAL FIRST RIB

Dr. Walter M. Brickner read a paper with the above title, for which see page 858.

Dr. Howard Lilienthal said that if there is indeed a normal first rib, it is more than probable the vessels and nerves are at fault and that they have been dragged over outer edge of the rib. As to the division of the rib and the technic: First of all, as to the presence of a condition of this type there is little doubt, not only because of the relief following the operation, but because of the relief of symptoms afforded by the use of a sling and raising of the shoulder by the patient. Whether the nerves or artery are most to blame for the symptoms the speaker was not so sure. He had an idea it was pressure of the subclavian artery on the rib which is quite as apt to cause pain as the nerve, the nervi vasorum being sensory. The distribution of the brachial plexus is so varied that one could probably not make a diagnosis as to whether it was nerve or vessel which caused the pain. As to the relief,

if there is pressure on the vessel over the edge of the first rib, removal of that edge should produce relief. Handling the brachial plexus even very lightly and carefully will often cause neuritis, sometimes lasting several months, although it usually disappears after six weeks.

Doctor Lilienthal said he had noticed that when the first rib is divided from behind, as a paravertebral thoracoplasty, the rib will drop an astonishing distance, even to the second or third intercostal space posteriorly, and does not go back again. So it makes little difference if one takes periosteum or not. Doctor Brickner's incision, which is original with him, is by far preferable to any known to the speaker. The scar was very beautiful and, even in this short time, not obtrusive.

Dr. John J. Moorhead said that Doctor Brickner had given another cause for painful shoulders. The speaker had not had any experience with such cases as had been described in the paper of the evening, but he wished to show X-rays of a case of bilateral supernumerary cervical ribs which had right-sided symptoms for four months, but the condition had been first recognized four years ago. The post-operative X-rays show the removal of one inch of rib on the right side in March, 1926. The relief from neural and vascular symptoms up to the present time had been perfectly satisfactory. The operation was done by an incision posterior to the external border of the mastoid and the rib was removed by a Gigli saw.

Dr. Byron Stookey said that the differential diagnosis of pain in the arm caused by cervical rib syndrome or pressure by a normal first rib or so-called brachial neuritis is fraught with considerable difficulty. In many the symptoms are entirely subjective without definite objective signs. Pain and weakness of the arm may be due to a variety of dissimilar conditions. Persistent unradicular pain may be due to intrinsic spinal cord disease; to discreet circumscribed spinal cord tumors such as a chondroma beneath a nerve root or a neurofibroma arising from a nerve root. These patients may complain of pain in the arm for several years. They are often treated for so-called brachial neuritis until further evolution of the disease indicates its spinal cord origin.

Another common source of pain in the arm which Dr. Louis Casamajor and the speaker have recognized for a number of years in the Vanderbilt Clinic is a myositis of one or more of the shoulder girdle muscles with pain radiating down the outer or inner aspect of the arm, indefinite and vague sensory changes, and some weakness of the extremity. Eight of these patients were waiting for a neuro-surgical consultation at the Vanderbilt Clinic several years ago, having been diagnosed by competent neurologists as brachial neuritis, so similar is their symptomatology. All proved to be myositis of one or more of the shoulder girdle muscles and all were relieved of their symptoms by appropriate massage and physiotherapeutic measures.

The diagnosis is made by having the patient in such position as to relax the shoulder girdle muscles. This is best accomplished by having the patient prone with the forearm and hands over the edge of the table. A search is

then made for tender nodules in the muscles of the shoulder girdle. These are best felt with the thumb and are usually found in the teres major, infraspinous, supraspinatus and trapezius muscles. The nodule is discreet and exquisitely tender to deep pressure. When such a nodule is found the patient resents vividly any deep pressure upon it.

Massage directed to the areas of induration in the muscle will usually clear up all the symptoms within four to six weeks. The diagnosis of myositis of the shoulder girdle muscles is not as frequently made as it should be. The speaker was in entire agreement with Oppenheim's (1908) view that brachial neuralgia is a rare affection.

The production of pressure symptoms by a normal first thoracic rib is an extremely interesting problem. The speaker agreed with Doctor Lilienthal in the belief that the abnormality is not in the rib but in the soft tissues—namely, the brachial plexus.

By transplantation of limb buds it has been shown that the position of the limb bud determines in a measure the component segmental innervation of the limb bud. For example, if the limb bud has a more cephalic position its innervation is more cephalic and vice versa. Thus a normal limb bud arising a segment or two more cephalic would determine a more cephalic cervical nerve contribution to it while a limb bud arising a segment or two more caudal would determine a more caudal cervical innervation—thus, for example, in the former limb bud the brachial plexus would be made up of a large contribution from the fourth cervical root while in the latter form the fourth cervical would contribute no fibres but instead a larger contribution would be derived from the first thoracic or second thoracic nerve. Thus the more caudal cervical nerves come to innervate the limb bud having the more caudal position. It is in this type of plexus that symptoms of rib pressure by a normal first thoracic rib on the plexus is likely to occur. The limb bud and nerves to the limb bud have shifted caudalward while the thoracic skeletal structures have retained their normal position. Consequently, when indisputable signs of pressure on the lower roots of the brachial plexus are evident removal of the first thoracic rib is indicated. The reader of the paper has called attention to an important mode of treatment other than surgical measures which may be useful in those cases in which the pressure exerted is relatively slight. It is in any case a measure well worth trying before attempting any surgical procedure and especially until the diagnosis is well established and the differential diagnosis made.

Doctor Brickner, in closing the discussion, said in reply to Doctor Lilienthal, that although he had demonstrated and reported a case in which there was evidence of pressure on the subclavian artery this is unusual, for even when there are vascular symptoms these are usually vasomotor, due rather to plexus than to blood-vessel pressure, *i.e.*, to pressure chiefly upon the lower cord as it passes over the *inner* edge of the first rib.

He did not touch upon the mechanics of the condition for, as he stated in his paper, he had dealt with a consideration of these in his

earlier publication and had then discussed the embryologic and developmental factors referred to by Doctor Stookey. While one of the photographs of Doctor Brickner's case taken six days after the operation *did* appear to show a little drooping of the eyelid on the opposite (unaffected) side, he could assure Doctor Stookey that this patient had no ptosis, enophthalmos or Horner's syndrome on either side, also that she had no rudimentary (cervical) rib or abnormality long seventh cervical transverse processes. Moreover, a long transverse process is not a rudimentary rib. He regretted that Doctor Stookey had understood him to say that there was any drooping of the rib in these cases. The ribs are normal in position as well as in shape. When there is any droop it is of the shoulder, dragging the plexus over an entirely normal rib. No doubt there are cases of myositis causing pain resembling that of brachial neuritis; but surely such cases as he had reported, with torturing pain over periods of many years, with vasomotor symptoms and, some of them, with typical lower cord irritation symptoms, could not be confused with myositis.

BRIEF COMMUNICATIONS

THE IMMEDIATE APPEARANCE OF A FRACTURE OF THE LOWER EXTREMITY OF THE RADIUS

THERE recently came into our charge the body of J. E., a colored man of thirty-four years (No. 1447), who had died of "alcoholism." A friend hit him on the jaw and fractured the mandible through the socket of the right second bicuspid tooth. The injured man fell over to the left and reaching out with the hand to break his fall, sustained a fracture of the left wrist. Dying almost immediately, he was removed to the County Morgue and thence to the laboratory, thus giving us the opportunity to study the features of a newly made fracture of the lower extremity of the radius without impaction.

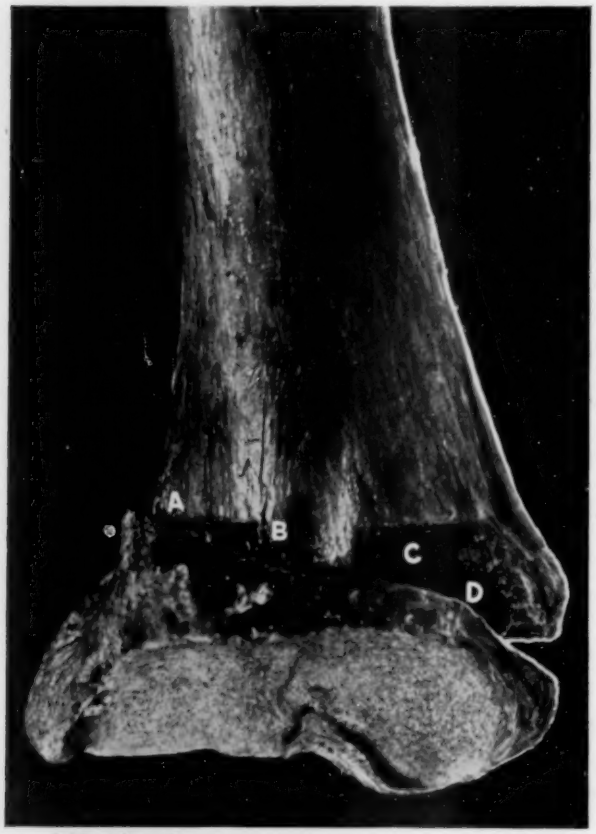

FIG. 1.—Fracture of the lower extremity of the left radius. No. 1447, male, negro, thirty-four. Fragments in displacement, seen from behind. Typical displacement and rotation; no impaction. A. B. D. Projections on lower fragment with crushed cancellous tissue. C. Depression with crushed cancellous tissue. These conditions are apparent also in Figs. 2 and 3.

Figure 1 shows the fragments as they appeared after maceration when restored to their relative position. There is typical displacement of lower fragment backwards and outwards with rotation in the same directions.

Figure 2 shows the fragments in normal relationship to each other as the parts were before fracture. There is a short fissured fracture running up the shaft from the region of the dorsal radial tubercle and a large area of thin compact tissue of the dorsal aspect of the bone is thoroughly splintered and lost in maceration.

The fractured faces, being perfectly fresh, never impacted, and having been macerated with the utmost care, are most instructive (Fig. 3).

In the fractured face of lower fragment are three depressions subdivided

FIG. 2.—Fragments restored to natural position to show the amount of tissue actually lost.

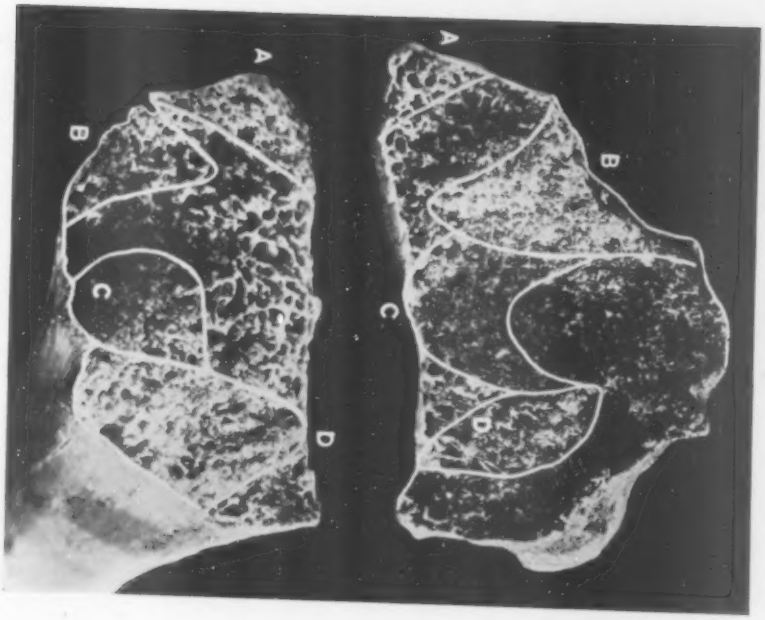

FIG. 3.—Fractured faces of fragments. Lower fragment above, upper below. Note the crushed cancellous tissue, the several corresponding areas of which have been lettered to indicate the contacts at the moment of impact.

from each other by two intervening rounded elevations. Correspondingly the upper fragment has three elevations separated by two roughly antero-posterior grooves. Although impaction did not take place in this bone, it is easy to see just how and where impaction usually occurs for the areas of upper and lower fragments which have been driven violently against each other are readily identified by their crushed cancellous tissue. Upon the basis of the damage to the cancellous tissue we have picked out by white encircling lines the corresponding areas on the two fracture faces. Areas which have been in contact with each other at the moment of impact are indicated by the same letter.

The sigmoid outline of the fracture through the lower extremity of the radius follows pretty definitely the plane apparent in bones of which the lower end has crumbled after maceration and hence is seemingly determined by the texture of the cancellous tissue rather than by the violence of the glancing blow. If impaction occurs, it takes place at the areas to which attention has been drawn.

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INFECTIONS OF THE FACE

In the issue of the Annals of Surgery, March, 1927, there is an article on Infection of the Face, with reports of interesting cases of carbuncle of the face, by Dr. John Price. He was kind enough to refer to a paper of my own on the same subject.

I take this opportunity to correct a wrong impression. I did not wish to give the impression that incision into circumscribed foci in the lip or nostril would lead to disaster. I have seen a number of these infections incised and have incised several myself with no untoward outcome. Two of the patients reported in the paper, one by Reverdin and one by Powers, recovered following incisions. Nor do I wish to imply that recovery will follow if they are protected from injury but not incised. I thought, when I wrote the paper and still think, that repeated incisions and repeated trauma, especially in the early stage and in the later stage when the *focus of infection* is not easily made out, are factors determining the spread of infection.

I know from experience that many heal without any intervention, even when there is brawny swelling and widespread œdema.

In such cases as those reported it would be interesting if we could have controls with and without incision and drainage. I imagine that opening the focus at a certain stage relieves pain; I do not believe it shortens the course of the infection or influences favorably the outcome.

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TRACTION IN THE REDUCTION OF A SUPRACONDYLAR "T" FRACTURE OF THE HUMERUS

INCREASING use is being made of skeletal traction in the treatment of fractures of the long bones. There is, however, little to be found in the

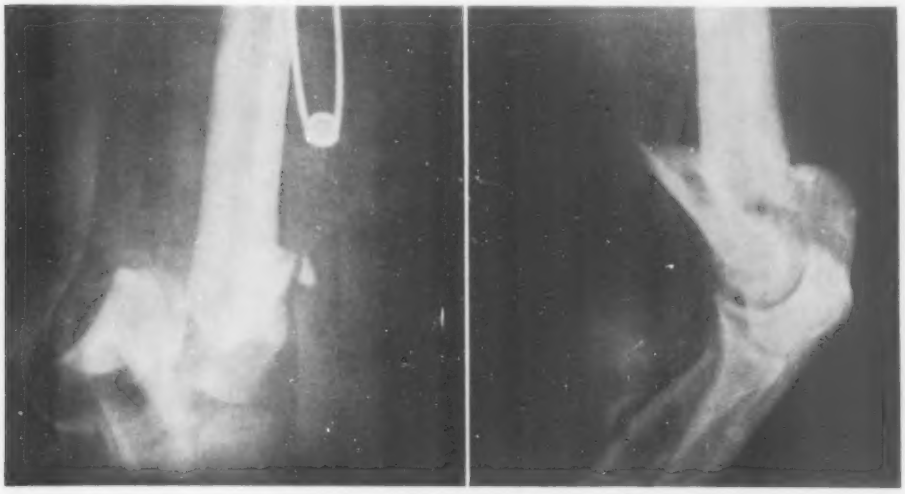

FIG. 1.—Showing extent of primary injury.

literature advocating this method in the care of fractures of the lower end of the humerus.

J. C., a man of forty, was admitted to the First Surgical Division, Bellevue Hospital, July 28, 1925. X-ray showed a supracondylar "T" fracture of the humerus with over-

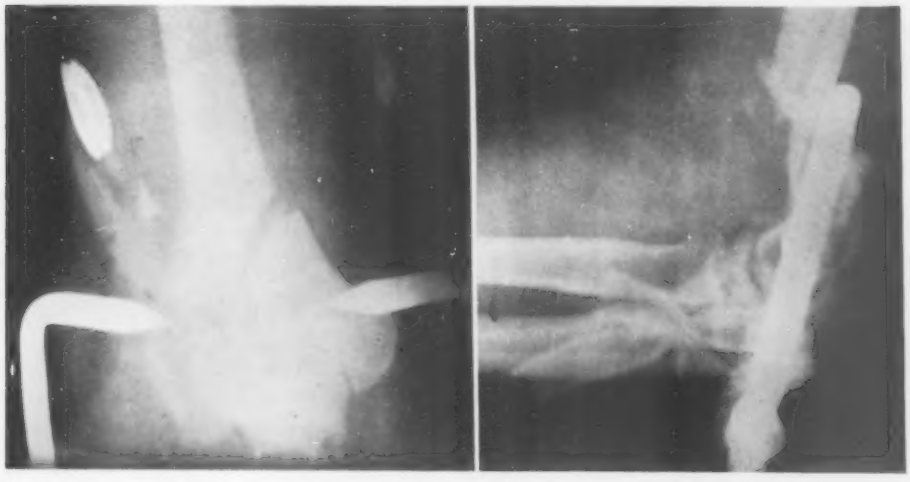

FIG. 2.—Showing position of fragments, forty-eight hours after application of calipers.

riding, and extreme separation of the two lower fragments (Fig. 1). A satisfactory reduction required traction in the long axis of the humerus, together with lateral pressure on the lower fragments. It seemed that these requirements could be most readily met by the use of tongs. Under ether anæsthesia and with a tourniquet applied to the upper

arm, and incision was made over each supracondylar ridge. The periosteum was divided and a small hole bored with a bit and brace just proximal to each condyle. Into these holes the caliper points were placed and tension maintained by passing a rubber tube about the arms of the tongs. The patient was returned to bed and the arm put up in right angle traction. Gentle active motion was begun as soon as the effects of the anæsthetic had fully worn off. Figure 2 shows the position of the fragments after forty-

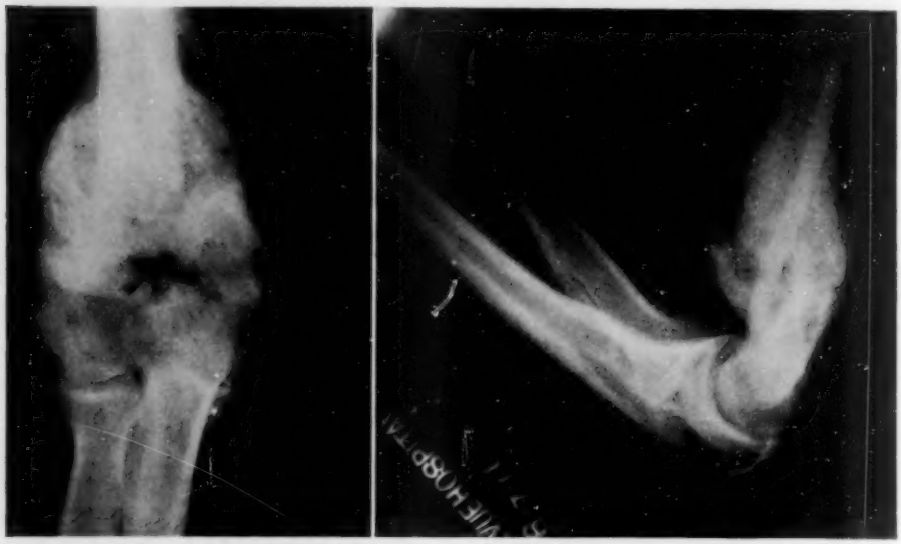

FIG. 3.—X-ray taken six months after injury.

eight hours of traction. After six days the calipers were removed as they were commencing to cause considerable discomfort, and the arm placed in moderately acute flexion in a posterior moulded splint. Figure 3 shows the elbow six months later at which time there was full pronation and supination with twenty degrees of flexion from the right angle and eighty degrees of extension. The patient, a bricklayer, has since resumed his occupation.

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INDEX TO VOLUME LXXXV

A

Abdominal Closure in Cases of Drainage, 400; Incisions Treated by "Open Method," 822; Surgery, Principle of the Quarantine in, 808.

Abscess, Entamœbic, of Transverse Colon, 461; of Lung, Closure of, by Muscle Transplant, 462; Subphrenic, Neck Pain in, 318; Traumatic, of the Spleen, 368.

Acid and Alkali Burns, Treatment of, 481.

Acoustic Nerve, Tumor of, 932.

Adenoma of the Thyroid, 107, 599.

Adenocarcinoma of Thyroid, Bone Metastases from, 603.

Adson, Alfred W.: Cervical Rib, 839.

Anæsthesia, Local, Ethyl Chloride in, 475; Regional, in Fractures, 765; Spinal, with Anhydrous Cocaine, 757.

Andrews, Edmund: The Vasomotor Reflex Arc, 116.

Aneurism of Internal Carotid Artery, 635; Popliteal, Obliterative Endoaneurismorrhaphy for, 288; Ruptured, of Femoral Artery, 926; Traumatic, Obliterative Endoaneurismorrhaphy for, 137.

Anomalies, Renal and Ureteral, 735.

Appel, Kenneth E.: Intradermal Test for the Determination of Post-operative Water Metabolism, 477; Post-operative Water Metabolism, 502.

Appendicitis, Acute, Chills in, 257; Mortality in, 89; Traumatic, 263.

Appendix, Adenocarcinoma of the, 464.

Arc, Vasomotor Reflex, 116.

Arkush, Albert S.: Auscultation in Diagnosis of Fracture, 319.

Armitage, Harry Marshall: Ruptured Gastric Ulcer in Infancy, 632.

Arteries, Large, Surgery of the, 173.

Artery, Aneurism of the Internal Carotid, 635.

Ashhurst, Astley P. C.: The Mortality in Appendicitis, 89.

Auscultation in Diagnosis of Fracture, 319.

Axilla, Persistent Skin Ulceration in, 289.

B

Bacteriæmia, Excision of Right Subclavian Vein for, 793.

Baldwin, James H.: Foreign Body in the Bladder, 288; A Study of Gas Gangrene in Civil Surgery, 161.

Balfour, Donald C.: Benign Tumors of the Stomach, 354.

Ball, Robert P.: Cerebrospinal Fluid Leak Due to a Fistula of the Cisterna Magna, 31.

Bancroft, Frederic W.: Adenocarcinoma of the Appendix, 464; Recurrent Obstruction of Common Bile Duct by Blood Clot, 465.

Beer, Edwin: Diverticulum of the Bladder, 927; Papillary Carcinoma of Kidney Pelvis, 930.

Behan, Richard J.: Traumatic Appendicitis, 263.

Bile Duct, Common, Post-operative Stricture of, 916; Recurrent Obstruction of, by Blood Clot, 465.

Biliary Tract, Surgery of, Some Results of, 565.

Bladder, Urinary, Diverticulum of the, 927; Extraperitoneal Hernia of the, 156; Foreign Body in the, 288; Gangrene of the, 269; and Sigmoid, Resection of, for Carcinoma, 297.

Bladder, Gall, Surgical Pathology of the, 239; Technic, 247.

Blair, Vilray Papin: Osteomyelitis of the Skull and Face, 1.

Bolling, Richard W.: Carcinoma of the Colin, 939; Megacolon, 938.

Bone Metastases from Adenocarcinoma of Thyroid, 603; Transplantation for Spondylolisthesis, 915.

Brachial Plexus Pressure by Normal First Rib, 858.

Brain Tumor, 951.

Bransfield, J. W.: Bilateral Congenital Dislocation of Hip, 778; Congenital Absence of Body of Thoracic Vertebra, 779; Fracture of Os Calcis, 779.

Breast Cancer, Thoracotomy for, 146.

Breast, Fat Necrosis of the, 438; Recurrent Neurogenic Sarcoma of the, 626; Tuberculosis of the, 625, 634.

Breasts, Massive Hypertrophy of the, 61.

Brenizer, Addison G.: Thyroiditis Accompanied by Hyperthyroidism, 339.

Brickner, Walter M.: Brachial Plexus Pressure by Normal First Rib, 858.

Brill, Selling: Intradermal Test for the Determination of Post-operative Water Metabolism, 477; Post-operative Water Metabolism, 502.

Bronchoscopic Aspiration, Relief of Post-operative Massive Collapse of Lung by, 152.

Brown, J. B.: Aneurism of Internal Carotid Artery, 635; Osteomyelitis of the Skull and Face, 1.

Bump, Warner S.: Massive Hypertrophy of the Breasts, 61.

Burden, Verne G.: Surgical Pathology of the Gall-bladder, 239.

Burns, Cicatricial Contraction Following, 472; Their Classification and Treatment, 490; Treatment of Acid and Alkali, 481;

Bussey, Donald C.: Teratoma Testis with Metastasis, 154.

C

Cæcal Ulcer, 942.

Cæcum, Dilatation and Perforation of the, 937; Tumors of the, 722.

Cancer of the Appendix, 464; Tongue, 142; Thoracotomy for Breast, 146.

Carcinoma of Ascending Colon, 141; of the Colon, 939; of Colon, Splenic Flexure of, 295; of Jejunum, 789; Papillary, of Kidney Pelvis, 930; of the Rectum, Laparotomy for, 732; Resection of Sigmoid and Bladder for, 297; of Stomach Nine Years After Operation, 471; of the Stomach, Observations on, 473; of Stomach, Partial Resection for, 470; of the Stomach, Late Results Following Partial Gastrectomy for, 295; of the Thyro-glossal Duct, 132.

Cardiorrhaphy, Pericardial Decompression After, 653.

Cardiospasm, 791.

Carnett, John B.: Chronic Strain of Lumbar Spine and Sacro-iliac Joints, 475; Chronic Strain of Lumbar Spine and Sacro-iliac Joints, 509; Ethyl Chloride in Local Anæsthesia, 475.

Carotid Artery, Internal, Aneurism of the, 635.

Carp, Louis: Foreign Bodies in the Intestine, 575.

Carson, William James.: Gangrene of the Bladder, 269.

Carter, R. Franklin: Pre-operative and Post-operative Treatment of the Gall-bladder Patient, 555.

Cauda Equina, Chronic Inflammation of, 934.

Cerebrospinal Fluid Leak, 31.

Cervical Lymph-nodes, Primary Endothelioma of, 347.

Cervical Rib, 839.

Charcot's Disease of Hip-joint, 951.

Chills in Acute Appendicitis, 257.

Cholecystitis, Hepatitis and Its Relation to, 535.

Christopher, Frederick: Neck Pain in Subphrenic Abscess, 318.

Cicatricial Contraction Following Burns, 472.

Cirrhosis of Liver, Omentopexy, Splenectomy, 922.

Clark, Harold E.: Tumors of the Cæcum, 722.

Clerf, Louis H.: Post-operative Massive Collapse of the Lung, 54.

Closure, Abdominal, in Cases of Drainage, 400.

Cocaine, Anhydrous, Spinal Anæsthesia with, 757.

Coffey, Jay R.: Cervical Rib, 839.

Coffey, Robert C.: Principle of the Quarantine in Abdominal Surgery, 808.

Collapse of Lung, Bilateral Massive, 608.

Cole, Warren H.: Suture of Wounds of the Heart, 647.

Colon, Carcinoma of the, 939; Carcinoma of Ascending, 141; Carcinoma of Splenic Flexure of, 295;; Transverse, Entamœbic Abscess of, 461.

Colostomy, Skin Flap Method of, 315.

Colp, Ralph: Chills in Acute Appendicitis, 257; Pedicle Graft for Os Calcis Covering, 612.

Common Duct Obstruction, Surgery of, 159.

Congenital Hypertrophic Pyloric Stenosis, 67.

Cottle, George F.: X-ray in Perforated Duodenal Ulcer, 450.

Croft, Leonard E.: Teratoma Testis with Metastasis, 154.

Crucial Ligament, Posterior, Injuries to, 592.

Cyanosis, Traumatic, 801.

Cyst, Unilocular, of the Spleen, 360.

Cysts, Mesenteric, 886.

D

Davidson, Edward C.: Treatment of Acid and Alkali Burns, 481.

DeCourcy, Joseph L.: Gall-bladder Technic, 247; Surgery of Common Duct Obstruction, 159.

DeLint, J. G.: Atlas of History of Medicine, Edited by, Review of, 637.

DeTakats, Geza: Extraperitoneal Hernia of the Bladder, 156; Jejunal Transplants to Stomach, 698.

Detroit Clinic, Thyroid Problem in a, 333.

Dilatation of the Stomach, Acute, Occurring Under General Anæsthesia, 704.

Dislocation of Hips, Bilateral Congenital, 778.

Diverticulitis, Duodenal, 73; of the Sigmoid, 84.

Diverticulum, Meckel's, Ulcer of, 252; of the Bladder, 927.

Douglas, John: Dilatation and Perforation of the Cæcum, 937.

Drainage, Abdominal Closure in Cases of, 400.

Dudley, Guilford S.: Mesenteric Thrombosis, 949; Retroperitoneal Tuberculosis, 950.

Duodenal Diverticulitis, 73.

Duodenal and Gastric Ulcers, Perforated, 713.

Duodenal Ulcer, Perforated, X-rays in, 450.

Duodenitis, 380.

Duskes, Emile: Metacarpal Central Giant-cell Tumors, 912.

Dwight, Kirby: Benign Hypertrophy of the Stomach and Linitis Plastica, 683.

E

Eisendrath, Daniel N.: Renal and Ureteral Anomalies, 735.

Eliason, Eldridge L.: Some Results of Surgery of Biliary Tract, 565; Results in Gall-bladder Surgery, 476; Osteochondritis of Hip, 915.

Embolism, Pulmonary, Post-operative, 44.

Endoaneurismorrhaphy, Obliterative, for Popliteal Aneurism, 288; for Traumatic Aneurism, 137.

Endothelioma, Primary, of Cervical Lymph-nodes, 347.

Entamœbic Abscess of Transverse Colon, 461.

Entero-enterostomy Seven Years after Gastro-enterostomy, 301.

Epithelioma of the Penis, 460.

Equina, Cauda, Chronic Inflammation of, 934.

Erdmann, John F.: Tumors of the Cæcum, 722.

Ethyl Chloride in Local Anæsthesia, 475.

Exophthalmos, Pulsating, 782.

F

Face, The Danger of Infection About the 104, 958; Treatment of Infections of the, 329.

Face and Skull, Osteomyelitis of the, 1.

Fat Necrosis of the Breast, 438.

Femoral Artery, Ruptured Aneurism of, 926.

Femur, Russell Apparatus for Treatment of Fracture of, 478, 529.

Ferguson, Lewis K.: Results in Gall-bladder Surgery, 476, 565.

Fifield, Lionel R.: Infections of the Hand, Edited by, Review of, 637.

Fischer, Hermann: Intrahepatic Gall-stones, 470; Partial Resection of Right Lobe of Liver for Hepatoma, 467; Partial Resection of Stomach for Carcinoma, 470.

Fish Bone, Ingested, Extrusion of, at Umbilical Region, 306.

Fistula of the Cisterna Magna, Cerebro-spinal Fluid Leak Due to, 31.

Flynn, Charles W.: Primary Endothelioma of Cervical Lymph-nodes, 347.

Fontaine, R.: Vasomotricity, 641.

Foreign Body in the Bladder, 288; Bodies in the Intestine, 575.

Fracture, Auscultation in Diagnosis of, 319; of Lower Extremity of Radius, Immediate Appearance of a, 956; of Os Calcis, 779; Supracondylar, "T," of the Humerus, Traction in the Reduction of a, 959.

Fractures of Femur, Russell Apparatus for Treatment of, 529; Regional Anæsthesia in, 765; of Transverse Processes of Lumbar Vertebræ, 519.

Frank, L. Wallace: Unilocular Cyst of the Spleen, 360.

Freedlander, Samuel Oscar: Treatment of Tetanus, 405.

G

Gall-bladder Patient. Pre-operative and Post-operative Treatment of the, 555; Surgery, Results in, 476; Surgical Pathology of the, 239; Technic, 247.

Gall-stones, Intrahepatic, 470.

Gallie, William Edward: Posterior Crucial Ligament Injuries, 592.

Gangrene of the Urinary Bladder, 269.

Garlock, John H.: Tendon Repair, 92.

Gas Gangrene in Civil Surgery, 161.

Gastrectomy, Partial, Late Results Following, for Carcinoma of the Stomach, 295.

Gastric and Duodenal Ulcers, Perforated, 713.

Gastric Tetany, 129.

Gastric Ulcer, Ruptured, in Infancy, 632.

Gastritis, Phlegmonous, 668.

Gastro-enterostomy, Entero-enterostomy Seven Years After, 301.

Gerster, John C. A.: Phlegmonous Gastritis, 668.

Giant-cell Tumors, Metacarpal Central, 912.

Gibson, Charles L.: Carcinoma of Ascending Colon, 141.

Gill, A. Bruce: Bone Transplantation for Spondylolisthesis, 915.

Gilmour, William R.: A Study of Gas Gangrene in Civil Surgery, 161.

Goitre, Substernal, Spontaneous Dislocation of a, 610.

Goldblatt, David: Burns, Their Classification and Treatment, 490.

Gottesman, J.: Fat Necrosis of the Breast, 438.

GREEN, NATHAN W.: Epithelioma of the Penis, 460; Long-standing Recovery from Pyloric Obstruction, 458; Melanoma of the Lower Extremity, 457.

H

Hæmatemesis, Recurrent, Due to Splenic Anæmia, 290.

HAINES, WILLARD D.: Diverticulitis of the Sigmoid, 84.

HARRINGTON, STUART W.: Relief of Post-operative Massive Collapse of Lung by Bronchoscopic Aspiration, 152.

HEAD, JEROME R.: Lipiodol in Relation to Thoracic Surgery, 194.

HEARN, WILLIAM P.: Post-operative Massive Collapse of the Lung, 54.

Heart, Suture of Wounds of the, 647; Wounds of, Importance of Pericardial Decompression in Treatment of, 653.

HEDBLOM, CARL A.: Lipiodol in Relation to Thoracic Surgery, 194.

HENDERSON, EARL F.: Benign Tumors of the Stomach, 354.

HENDERSON, MELVIN S.: Non-union of the Hip, 317.

Hepatitis and Its Relation to Cholecystitis, 535.

Hepatoma, Partial Resection of Right Lobe of Liver for, 467.

Hernia, Extraperitoneal, of the Bladder, 156; Lateral Ventral, 284; Transthoracic Abdominal, 797.

HEYD, CHARLES GORDON: Adenoma of Thyroid, 599; Bone Metastases from Adenocarcinoma of Thyroid, 603.

HIGGINS, CHARLES C.: Surgical Anatomy of Recurrent Laryngeal Nerve, 827.

HINTON, J. WILLIAM: The Danger of Infection About the Face, 104.

Hip-joint, Charcot's Disease of the, 951.

Hip, Osteochondritis of, 915; Non-union of the, 317.

Hips, Bilateral Congenital Dislocation of, 778.

History of Medicine, Atlas of the, Edited by J. G. DeLint, Review of, 637.

HOGUET, JOSEPH P.: Brain Tumor, 951; Charcot's Disease of Hip-joint, 951.

HOLMAN, EMILE: Observations on the Surgery of the Large Arteries, 173.

Human Pathology, Edited by Howard T. Karsner, Review of, 639.

Humerus, Osteogenic Sarcoma of, 942; Traction in the Reduction of a Supracondylar "T" Fracture of the, 959.

Hyperthyroidism, Acute Post-operative, 605; Thyroiditis Accompanied by, 339.

Hypospadia, Formation of Urethra in, 391.

I

Incisions, Abdominal, Treated by "Open Method," 822.

Infections of the Face, 329, 958; of the Hand, Edited by Lionel R. Fifield, Review of, 637.

INGELBY, HELEN: Carcinoma of the Thyroglossal Duct, 132.

INLOW, WILLIAM DEP.: Traumatic Abscess of the Spleen, 368.

Internal Carotid Artery, Aneurism of the 635.

Intestinal Obstruction, Acute, 919.

Intestine, Foreign Bodies in the, 575.

Intradermal Test for the Determination of Post-operative Water Metabolism, 477.

Intrahepatic Gall-stones, 470.

IVY, ROBERT H.: Enlarged Condyle of Mandible, 27.

J

JACKSON, ARNOLD S.: Ulcer of Meckel's Diverticulum, 252.

JANIK, ALFRED: Tumors of Tendon Sheaths, 897.

Jejunal Transplants to Stomach, 698.

Jejunum, Carcinoma of, 789; Primary Ulcer of the, 873; Recurrent Ulcer of, 790.

JOHN, HENRY J.: Chronic Tetany, 410.
JUDD, E. STARR: Duodenitis, 380.

K

KARSNER, HOWARD T.: Human Pathology, Edited by, Review of, 639.
KENNEDY, ROBERT H.: Fractures of Transverse Processes of Lumbar Vertebræ, 519.
Kidney Pelvis, Papillary Carcinoma of, 930.
Kidney, Polycystic, Traumatic Rupture of, 615.
KLOPP, EDWARD J.: Post-operative Stricture of Common Bile Duct, 916.

L

Laparotomy for Carcinoma of the Rectum, 732.
Laryngeal Nerve, Recurrent, Surgical Anatomy of, 827.
Laryngostenosis, Operative Relief of, 40.
Lateral Ventral Hernia, 284.
LEE, BURTON J.: Recurrent Neurogenic Sarcoma of Breast, 626; Tuberculosis of the Breast, 625.
LEHMAN, EDWIN P.: Transthoracic Abdominal Hernia, 797.
LEMESURIER, A. B.: Posterior Crucial Ligament Injuries, 592.
LERICHE, RENÉ: Vasomotricity, 641.
LEWISOHN, RICHARD: Carcinoma of Splenic Flexure of Colon, 295; Late Results Following Partial Gastrectomy for Carcinoma of the Stomach, 295.
Ligament, Posterior Crucial, Injuries to, 592.
LILIENTHAL, HOWARD: Mediastinal Sarcoma, 615.
Lung, Post-operative Massive Collapse of the, 54.
Linitis Plastica and Benign Hypertrophy of the Stomach, 683.
Lipiodol in Relation to Thoracic Surgery, 194.
Lipoma of the Testicle, 275.
Liver, Cirrhosis of, Omentopexy, Splenectomy, 922; Partial Resection of Right Lobe of, for Hepatoma, 467.
Lower Extremity, Melanoma of the, 457.
LOWSLEY, OSWALD SWINNEY: Urology, Edited by, Review of, 639.
Lumbar Spine, and Sacro-iliac Joints, Chronic Strain of, 475, 509.
Lumbar Vertebra, Fractures of Transverse Processes of, 519.
Lung, Bilateral Massive Collapse of, 608; Closure of Abscess of, by Muscle Transplant, 462.
Lymph-nodes, Cervical, Primary Endothelioma of, 347.
Lymphosarcoma, Resection of Stomach for, 138.

M

MACGUIRE, CONSTANTINE J., JR.: Carcinoma of Jejunum, 789; Recurrent Ulcer of Jejunum, 790.
MACLEAN, NEIL JOHN: Duodenal Diverticulitis, 73.
MAGE, SIGMUND: Regional Anæsthesia in Fractures, 765.
Malignant Growths of the Thyroid, 120.
Mandible, Enlarged Condyle of, 27.
MANN, FRANK C.: Jejunal Transplants to Stomach, 698.
MARTIN, FRANKLIN H.: South America, Edited by, Review of, 638.
MARTIN, WALTON: Hepatitis and Its Relation to Cholecystitis, 535; Infections of the Face, 958.
Massive Collapse of the Lung, Post-operative, 54.
MCCLURE, ROY D.: The Thyroid Problem in a Detroit Clinic, 333.
MCGUIRE, STUART: Formation of Urethra in Hypospadia, 391.
MCGLANNAN, ALEXIUS: Lateral Ventral Hernia, 284.

McIver, Monroe A.: Acute Dilatation of the Stomach Occurring Under General Anæsthesia, 704.

Meade, Richard H., Jr.: Tuberculosis of the Breast, 634.

Meckel's Diverticulum, Ulcer of, 252.

Mediastinal Sarcoma, 615.

Megacolon, 938.

Melanoma of the Lower Extremity, 457.

Mesenteric Cysts, 886; Thrombosis, 949.

Metabolism, Water, Intradermal Test for the Determination of Post-operative, 477.

Metacarpal Central Giant-cell Tumors, 912.

Metastases, Bone, from Adenocarcinoma of Thyroid, 603.

Mortality in Appendicitis, 89.

Morton, Charles Bruce: Observations on Peptic Ulcer, 207, 879.

Moschcowitz, Alexis V.: Cardiospasm, 791; Excision of Right Subclavian Vein for Bacteriæmia, 793; Osteomyelitis of the Pubic Bone, 792.

Musculospiral Nerve, Neurolysis for Cicatricial Strangulation, 300.

N

Nagel, Gunther W.: Duodenitis, 380.

Neck Pain in Subphrenic Abscess, 318.

Necrosis, Fat, of the Breast, 438.

Nerve Palsy, Late Post-operative Recurrent, 610.

Neuhof, Harold: Late Result of Transplantation of Toe for Missing Finger, 139; Obliterative Endoaneurismorrhaphy for Traumatic Aneurism, 137; Resection of Stomach for Lymphosarcoma, 138.

Neurofibroma, Spinal Cord, 933.

Neurogenic Sarcoma of Breast, Recurrent, 626.

Neurolysis for Cicatricial Strangulation of Musculospiral Nerve, 300.

New York Surgical Society, Transactions of, 137, 295, 457, 599, 789, 942.

New York Surgical Society and Philadelphia Academy of Surgery, Combined Meeting, 922.

Non-union of the Hip, 317.

O

Obstruction, Acute Intestinal, 919; of Common Duct, Surgery, 159; of Common Bile Duct, Recurrent, by Blood Clot, 465; Pyloric, Long-standing, Recovery from, 458.

O'Day, J. Christopher: Pericardial Decompression After Cardiorrhaphy, 653.

"Open Method," Abdominal Incisions Treated by the, 822.

Ormond, John K.: Torsion of an Intra-abdominal Testis, 280.

Os Calcis, Fracture of, 779; Pedicle Graft for Covering, 612.

Osteochondritis of Hip, 915.

Osteomyelitis, Acute, Treatment of, 428; Extensive, Re-formation of Radius Following, 945; Extensive, Re-formation of Ulna Following, 943; of the Pubic Bone, 792; of the Skull and Face, 1.

Osteoplastic Support of the Spine, 35.

Owen, Hubley R.: Carcinoma of the Thyro-glossal Duct, 132.

P

Palsy, Late Post-operative Recurrent Nerve, 610.

Papin, Edmund: Renal and Ureteral Anomalies, 735.

Parsons, William Barclay, Jr.: Adenoma of the Thyroid, 107; Late Post-operative Recurrent Nerve Palsy, 610; Spontaneous Dislocation of a Substernal Goitre, 610.

Pedicle Graft for Os Calcis Covering, 612.

Penis, Epithelioma of the, 460.

Peptic Ulcer, 207, 879.

Pericardial Decompression After Cardiorrhaphy, 653.

Pericarditis, Purulent, in Childhood, 659.

Pfeiffer, Damon B.: Recurrent Hæmatemesis Due to Splenic Anæmia, with Appendicitis and Cholelithiasis, 290.

Philadelphia Academy of Surgery, Transactions of the, 129, 288, 475, 778, 915.

Philadelphia Academy of Surgery and New York Surgical Society, Combined Meeting, Transactions of, 922.

Phlegmonous Gastritis, 668.

Pickhardt, Otto C.: Cæcal Ulcer, 942; Osteogenic Sarcoma of Humerus, 942; Re-formation of Ulna Following Extensive Osteomyelitis, 943.

Plastic Surgery, Contribution to, 185.

Plummer, Samuel C.: Massive Hypertrophy of the Breasts, 61.

Polycystic Kidney, Traumatic Rupture of, 615.

Pool, Eugene H.: Closure of Abscess of Lung by Muscle Transplant, 462; Entamœbic Abscess of Transverse Colon, 461; Malignant Growths of the Thyroid, 120.

Posterior Crucial Ligament Injuries, 592.

Post-operative Water Metabolism, 502.

Potter, Philip C.: Traction in the Reduction of a Supracondylar "T" Fracture of the Humerus, 959.

Price, John W., Jr.: Treatment of Infections of the Face, 329.

Pubic Bone, Osteomyelitis of the, 792.

Pulmonary Embolism, Post-operative, 44.

Pyloric Obstruction, Long-standing Recovery from, 458; Stenosis, Congenital Hypertrophic, 67.

Q

Quarantine, Principle of the, in Abdominal Surgery, 808.

R

Radius, Immediate Appearance of Fracture of Lower Extremity of, 956; Re-formation of, Following Extensive Osteomyelitis, 945.

Ravdin, I. S.: Primary Ulcer of the Jejunum, 873.

Rectum, Laparotomy for Carcinoma of the, 732.

Recurrent Laryngeal Nerve, Surgical Anatomy of, 827.

Reder, Francis: Abdominal Closure in Cases of Drainage, 400.

Regional Anæsthesia in Fractures, 765.

Renal and Ureteral Anomalies, 735.

Retroperitoneal Tuberculosis, 950.

Rib, Cervical, 839; Normal First, Brachial Plexus Pressure by, 858.

Roberts, George W.: Abdominal Incisions Treated by the "Open Method," 822.

Roberts, Kingsley: Abdominal Incisions Treated by the "Open Method," 822.

Rodman, J. Stewart: Acute Intestinal Obstruction, 919; Obliterative Endoaneurismorrhaphy for Popliteal Aneurism, 288; Persistent Skin Ulceration in Axilla, 289.

Roeder, Clyde A.: Lipoma of the Testicle, 275.

Rosenblatt, Millard S.: Traumatic Cyanosis, 801.

Royster, Hubert A.: The Influence of Tradition in Surgery, 321.

Russell Apparatus for Treatment of Femur Fractures, 478, 529.

Ryan, Thomas J.: Use of Russell Apparatus in Treatment of Fracture of Shaft of Femur, 478, 529.

S

Sacro-iliac Joints and Lumbar Spine, Chronic Strain of, 475, 509.

Santee, Harold E.: Acute Post-operative Hyperthyroidism, 605; Bilateral Massive Collapse of Lung, 608.

Sarcoma, Mediastinal, 615; Osteogenic, of Humerus, 942; Recurrent Neurogenic, of the Breast, 626.

SCHLEY, WINFIELD SCOTT: Carcinoma of Stomach Nine Years After Operation, 471; Cicatricial Contraction Following Burns, 472; Skin Graft for Web Fingers, 473.

SCHWYZER, ARNOLD: Operative Relief of Laryngostenosis, 40.

SEMKEN, GEORGE H.: Cancer of Tongue, 142; Thoracotomy Breast Cancer, 146.

SHALLOW, THOMAS A.: Pulsating Exophthalmos, 782.

Sigmoid and Bladder, Resection of, for Carcinoma, 297.

Sigmoid, Diverticulitis of the, 84.

SISTRUNK, WALTER E.: Contribution to Plastic Surgery, 185; Laparotomy for Carcinoma of the Rectum, 732.

Skin Flap Method of Colostomy, 315.

Skin Graft for Web Fingers, 473.

Skull and Face, Osteomyelitis of the, 1.

South America, Edited by Franklin H. Martin, Review of, 638.

SPALDING, OTIS B.: X-ray in Perforated Duodenal Ulcer, 450.

SPEED, KELLOGG: Post-operative Pulmonary Embolism, 44.

Spinal Anæsthesia with Anhydrous Cocaine, 757.

Spinal Cord Neurofibroma, 933.

Spine, Chronic Strain of the Lumbar, and Sacro-iliac Joints, 509; Osteoplastic Support of the, 35.

Spleen, Traumatic Abscess of the, 368; Unilocular Cyst of the, 360.

Splenic Flexure of Colon, Carcinoma of, 295.

Spondylolisthesis, Bone Transplantation for, 915.

SPURLING, ROY G.: Cerebrospinal Fluid Leak Due to a Fistula of the Cisterna Magna, 31.

STEINBERG, MOSES E.: Skin Flap Method of Colostomy, 316.

STENBUCK, JOSEPH B.: Perforated Gastric and Duodenal Ulcers, 713.

Stenosis, Pyloric, Congenital Hypertrophic, 67.

STETTEN, DEWITT: Entero-enterostomy Seven Years After Gastro-enterostomy, 301; Extrusion of Ingested Fish Bone at Umbilical Region, 306; Neurolysis for Cicatricial Strangulation of Musculospiral Nerve, 300; Re-formation of Radius Following Extensive Osteomyelitis, 945; Resection of Sigmoid and Bladder for Carcinoma, 297.

ST. JOHN, FORDYCE B.: Observations on Carcinoma of the Stomach, 473.

Stomach, Acute Dilatation of the Stomach Occurring Under General Anæsthesia, 704; Benign Hypertrophy, of the, and Linitis Plastica, 683; Benign Tumors of the, 354; Carcinoma of the, Observations on, 473; Carcinoma of, Nine Years After Operation, 471; Jejunal Transplants to, 698; Late Results Following Partial Gastrectomy for Carcinoma of the, 295; Partial Resection of, for Carcinoma, 470; Resection of, for Lymphosarcoma, 138.

STORM, W. HAROLD: Gastric Tetany, 129.

STRACHAUER, ARTHUR C.: Congenital Hypertrophic Pyloric Stenosis, 67.

Strain, Chronic, of Lumbar Spine and Sacro-iliac Joints, 475, 509.

Stricture, Post-operative, of Common Bile Duct, 916.

Subclavian Vein, Excision of Right, for Bacteriæmia, 793.

Subphrenic Abscess, Neck Pain in, 318.

Substernal Goitre, Spontaneous Dislocation of a, 610.

Supracondylar "T" Fracture of the Humerus, Traction in the Reduction of a, 959.

Surgery of Biliary Tract, Some Results of, 565; Results in Gall-bladder, 476; The Influence of Tradition in, 321.

SWARTLEY, WILLIAM BLAINE: Mesenteric Cysts, 886.

T

Taylor, Alfred S.: Chronic Inflammation of Cauda Equina, 934; Spinal Cord Neurofibroma, 933; Tumor of Acoustic Nerve, 932.
Tendon Repair, 92; Sheaths, Tumors of, 897.
Testicle, Lipoma of the, 275.
Testis, Teratoma, with Metastasis, 154; Torsion of an Intra-abdominal, 280.
Tetanus, Treatment of, 405.
Tetany, Chronic, 410; Gastric, 129.
Thoracic Surgery, Lipiodol in Relation to, 194.
Thoracic Vertebra, Congenital Absence of Body of, 779.
Thoracotomy for Breast Cancer, 146.
Thrombosis, Mesenteric, 949.
Thyro-glossal Duct, Carcinoma of the, 132.
Thyroid, Adenoma of the, 107, 599; Adenocarcinoma of, Bone Metastases from, 603; Malignant Growths of the, 120; Problem in a Detroit Clinic, 333.
Thyroiditis Accompanied by Hyperthyroidism, 339.
Todd, T. Wingate: Immediate Appearance of Fracture of Lower Extremity of Radius, 956.
Toe, Late Result of Transplantation of, for Missing Finger, 139.
Tongue, Cancer of, 142.
Torsion of an Intra-abdominal Testis, 280.
Tradition in Surgery, The Influence of, 321.
Transthoracic Abdominal Hernia, 797.
Traumatic Appendicitis, 263; Cyanosis, 801.
Tuberculosis of the Breast, 625, 634.
Tuberculosis, Retroperitoneal, 950.
Tumor of Acoustic Nerve, 932; Brain, 951.
Tumors of the Cæcum, 722; Giant-cell, Metacarpal Central, 912; of the Stomach, Benign, 354; of Tendon Sheaths, 897.

U

Ulcer, Cæcal, 942; of Meckel's Diverticulum, 252; Peptic, 207, 879; Perforated Duodenal, X-ray in, 450; Primary, of the Jejunum, 873; Recurrent, of Jejunum, 790; Ruptured Gastric, in Infancy, 632.
Ulceration, Persistent Skin, in Axilla, 289.
Ulna, Re-formation of, Following Extensive Osteomyelitis, 943.
Umbilical Region, Extrusion of Ingested Fish Bone at, 306.
Unilocular Cyst of the Spleen, 360.
Ureteral and Renal Anomalies, 735.
Urethra, Formation of, in Hypospadia, 391.
Urology, Edited by Oswald Swinney, Lowsley, Review of, 639.

V

Vasomotor Reflex Arc, 116.
Vasomotricity, 641.
Ventral Hernia, Lateral, 284.
Vertebra, Congenital Absence of Body of Thoracic, 779.
Vertebræ, Lumbar, Fractures of Transverse Processes of, 519.

W

Water Metabolism, Intradermal Test for the Determination of Post-operative, 477, 502.
Web Fingers, Skin Graft for, 473.
Wells, J. Ralston: Spinal Anæsthesia with Anhydrous Cocaine, 757.
Whipple, Allan O.: Cirrhosis of Liver, Omentopexy, Splenectomy, 922; Ruptured Aneurism of Femoral Artery, 926.
Wilensky, Abraham O.: Treatment of Acute Osteomyelitis, 428.
Williamson, Ernest G.: Purulent Pericarditis in Childhood, 659.
Worcester, James N.: Traumatic Rupture of Polycystic Kidney, 615.
Wounds of the Heart, Suture of, 647.
Wreden, R. R.: Osteoplastic Support of the Spine, 35.

X

X-ray in Perforated Duodenal Ulcer, 450.

Z

Zemansky, A. Philip: Fat Necrosis of the Breast, 438.

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TRAUMATIC CYANOSIS—ITS PATHOLOGICAL PHYSIOLOGY 801
MILLARD S. ROSENBLATT, M.D. ..... DETROIT, MICH.

APPLICATION OF THE PRINCIPLE OF THE QUARANTINE IN ABDOMINAL SURGERY 808
ROBERT C. COFFEY, M.D. ..... PORTLAND, OREGON

ABDOMINAL INCISIONS TREATED BY THE "OPEN METHOD" 822
GEORGE W. ROBERTS, M.D. AND KINGSLEY ROBERTS, M.D. ..... NEW YORK, N.Y.

SURGICAL ANATOMY OF THE RECURRENT LARYNGEAL NERVE WITH ESPECIAL REFERENCE TO THYROID SURGERY 827
CHARLES C. HIGGINS, M.D. ..... CLEVELAND, OHIO

CERVICAL RIB 839
ALFRED W. ADSON, M.D. AND JAY R. COFFEY, M.D. ..... ROCHESTER, MINN.

BRACHIAL PLEXUS PRESSURE BY THE NORMAL FIRST RIB 858
WALTER M. BRICKNER, M.D. ..... NEW YORK, N.Y.

PRIMARY ULCER OF THE JEJUNUM 873
I. S. RAVDIN, M.D. ..... PHILADELPHIA, PA.

OBSERVATIONS ON PEPTIC ULCER 879
CHARLES BRUCE MORTON, M.D. ..... ROCHESTER, MINN.

MESENTERIC CYSTS 886
WILLIAM BLAINE SWARTLEY, M.D. ..... PHILADELPHIA, PA.

TUMORS OF TENDON SHEATHS 897
ALFRED JANIK, M.D. ..... LWÓW, POLAND

METACARPAL CENTRAL GIANT-CELL TUMORS 912
EMILE DUSKES, M.D. ..... BALTIMORE, MD.

TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY 915
STATED MEETING HELD FEBRUARY 7, 1927

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY 922
JOINT MEETING WITH PHILADELPHIA ACADEMY OF SURGERY HELD FEBRUARY 9, 1927
STATED MEETING HELD FEBRUARY 23, 1927 942

BRIEF COMMUNICATIONS: *Todd:* Immediate Appearance of Fracture of Lower Extremity of Radius, 956; *Martin:* Infections of the Face, 958; *Potter:* Traction in Reduction of Supracondylar "T" Fracture of Humerus, 959.

INDEX 961

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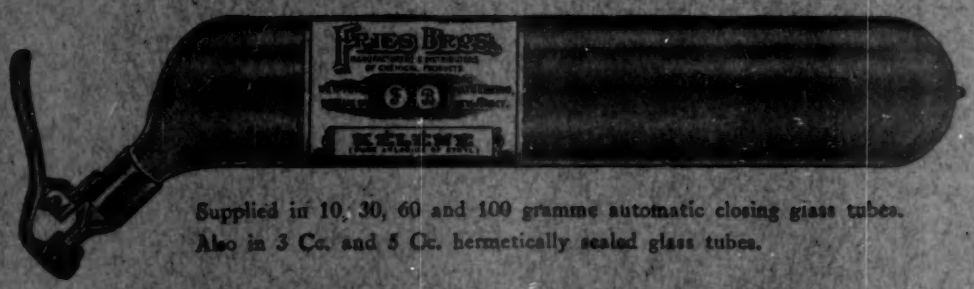

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